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Baseline Measurement Test Results for the Cat-Ox Demonstration Program

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Baseline Measurement Test Results for the Cat-Ox Demonstration Program

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ABSTRACT

This report summarizes the results of the Baseline Measurement Test conducted for the Cat-Ox Demonstration Program. The test was carried out on Steam Generator Unit No. 4 of the Wood River Station of the Illinois Power Company in November and December 1971. The report describes the measurement program for the test and procedures used to process: data output from the continuous measurement system; steam generator operating data; and data obtained from manual measurements. It also provides information on the data reduction system, and the contents of the data base used for baseline test calculations. It presents test results for: net and gross efficiency--varying load level, excess air, and fuel type; gas mass flow and gas volume flow--varying load level and fuel type; and grain loading--varying load level, fuel type, and the soot blowing cycle. It also presents results for an overall sulfur balance, and for comparing continuous measurement results with manual measurements and with theoretical values.

This report was submitted in partial fulfillment of Contracts F19268-71-C-002 and 68-02-0650, under the sponsorship of the Environmental Protection Agency.

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SECTION I

CONCLUSIONS

All primary objectives of the Baseline Measurement Test were achieved in the five week period of testing on Steam Generator Unit No. 4 of the Wood River Station of the Illinois Power Company.

A relationship was defined between control settings and operating conditions for Unit No. 4 and flue gas properties at the Cat-Ox/Steam Generator interface; baseline performance of the steam generator was characterized in terms of emission levels and quantitative data were obtained which can be used to support the establishment of realistic performance standards. Operating experience was also obtained in the testing and calibration of the measurement procedures and hardware to be used in the one-year demonstration test, and quantitative information was obtained on the overall operability and reliability of Steam Generator Unit No. 4.

Data are provided in this report in the form of tabular results for a set of twenty-one separate tests, each at different operating conditions. To maintain these conditions during each test (a period of approximately ten hours), it was necessary to control the following: load factor, fuel type, soot blowing, and excess air.

In general, no test results were found which were significantly different from anticipated results, either in terms of magnitude or in terms of effects of the parameters examined.

Net and gross efficiencies were on the average higher at a 75 MW load level when compared with average values at 100 MW and 50 MW load levels; but the differences were not of the magnitude to be significant. No significant differences were found in net and gross efficiencies for the three types of fuel tested at the 100 MW level.

Measured gas mass flow rates for sulfur dioxide were consistent with control settings and sulfur content of the fuel. Measured gas flow rates for carbon dioxide were not significantly different for the three types of fuel tested. Oxygen mass flow rates decreased with decreasing load level, and were found not to be significantly different for two of the fuel types for a fixed load level. Measured gas mass flow rates for nitric oxide were significantly lower for tests performed with the fuel type that was predominantly natural gas than for tests performed with the other two fuel types.

Total gas mass flow rates were derived from the measured flow rates for individual gases and, as such, showed the same relationships as the individual gases (i.e., same decrease with decreasing load level and same increase with increased excess air).

The results of a sulfur balance computation, comparing measurements of sulfur flow input to the system in the fuel with sulfur flow output from the system in the stack gas, were in good agreement for all tests. These results led to the conclusion that the total combined error in sulfur dioxide and gas flow measurements was low.

Grain loading measurements were found to be consistent with the ash content of the fuels utilized and the soot blowing cycle employed. No specific patterns were found in the analysis of results in terms of mechanical collection efficiencies.

In the comparisons between manual sampling and continuous measurement results with theoretical expected values of gaseous concentrations, closer agreement was found between the continuous measurement results and the theoretical values.

The proximate and ultimate analyses of the coal and the elemental analyses of pulverizer rejects, furnace bottom ash, and fly ash did not provide any specific pattern beyond the expected results. The elemental analyses are of special value, however, in that they do provide the means for determining emission rates to the ambient atmosphere for a number of elements not usually examined in emission testing programs.

SECTION II

INTRODUCTION

BACKGROUND

The Environmental Protection Agency (EPA) is actively engaged in a number of programs to demonstrate sulfur oxide emission control processes applicable to stationary sources. These demonstration programs are based upon operation of an emission control system of such size and for such duration as to permit technical and economic scale-up of operating factors to define the commercial practicality of the process for potential industrial users. Among the candidate processes to be evaluated is the Cat-Ox process developed by Monsanto Enviro-Chem Systems Inc. under contract to the Illinois Power Company and the Environmental Protection Agency. The Cat-Ox process as developed by Monsanto is based upon the catalytic oxidation of sulfur dioxide to sulfur trioxide and subsequent reaction with water in the flue gas to form sulfuric acid. The sulfuric acid formed is to be sold to offset the operating costs associated with the process.

Four major task areas have been defined by MITRE under contract to EPA to provide "Test Program Development Work of the Cat-Ox Demonstration Unit (CPA 70-161)." The first of the task areas concerns the "Definition of Test Requirements," determined by means of an examination of the requirements of potential users, an examination of the stated technical and economic capabilities of the Cat-Ox process, and the performance of a requirements analysis defining the types and levels of test data required to quantify the operability, reliability, and emission control effectiveness of the Cat-Ox process. The second of the task areas concerns a "Baseline Measurement Test," in which the baseline operability, reliability, and emission levels of the stationary source are determined prior to installation of the control process. The third task area concerns the performance of a "One-Year Demonstration Test" wherein a measurement program is conducted which will fully characterize the Cat-Ox process emission control performance; quantify the operating economics of the process; and establish the operability, reliability, and maintainability of the Cat-Ox process and the resulting effects on the steam generator with which it is integrated. The fourth task area concerns the "Demonstration Evaluation" where reduced test data are translated into quantified statements on the technical and economic adequacy of the process.

To date, the first two of the major task areas have been completed. Requirements for testing have been defined in part in a baseline measurement test plan for the Cat-Ox Demonstration Program, and the baseline measurement test was conducted under the second major task in conformance with this test plan.

TEST OBJECTIVES

The objectives of the Baseline Measurement Test are to: 1) determine the relationship between control settings and operating conditions for Unit No. 4, and flue gas properties at the Cat-Ox/Steam Generator interface, 2) characterize baseline performance in terms of operability, reliability, and emission levels of Unit No. 4 prior to installation of the process, 3) test and calibrate measurement procedures and hardware to be used in the one-year demonstration test, and 4) obtain quantitative data supporting the establishment of realistic performance standards for all emitted pollutants.

SCOPE OF TEST

To meet these objectives, a test program was developed which consisted of twenty-one (21) separate tests, each of approximately ten hours duration. These twenty-one tests were conducted over a five-week period beginning November 8, 1971 and ending December 9, 1971.

Each of the twenty-one tests represented a particular combination of operating levels for the major steam generator parameters (load factor, fuel type, soot blowing, and excess air). The combinations of operating levels were selected so as to provide the maximum of information in a minimum number of tests, varying the parameters on a "one-at-a-time" basis.

Two supplementary gas traversal tests were also conducted to determine the pattern of leakage at the air heater (measurement position No. 2) and the gas flow pattern midway in the stack (measurement position No. 3).

A supplementary test was also conducted in which all factors were held constant except for burner angle, which was varied in steps from the minimum to maximum position.

For all of the tests, key steam generator operating parameters were monitored, samples of coal and ash were obtained at various points in the steam generator, gas samples were manually obtained, particulate grain loadings were determined by manual sampling, and temperatures, pressures, gas flows and gas concentrations were monitored by a MITRE designed continuous measurement system.

SECTION III

MEASUREMENT PROGRAM

This section describes the procedures followed by the MITRE test team in preparing for the test program, the steps followed in conducting the tests, and the data management procedures utilized throughout the measurement program.

Descriptive information is also provided in this section concerning the measurement locations, measurement parameters, and the steam generator operating conditions defined for each test.

PRELIMINARY MEASUREMENTS

As part of the Baseline Measurement Program, a number of preliminary measurements were made prior to the initiation of the twenty-one tests.

The objective of this preliminary measurement effort was to provide the necessary background information on isokinetic sampling techniques, rates of particulate loading in sampling equipment, and effects of power plant ambient conditions on the measurements.

This information was then used to determine ranges of gas and particulate concentrations to be encountered in the measurement program, to confirm the sampling frequency and sampling positions utilized in the measurement program, and to identify any changes in operating procedures or modifications in test equipment necessary for the primary measurement effort.

The preliminary measurements were conducted over a two-week period beginning September 28, 1971. A summary of the test schedule and test conditions followed during this preliminary measurement effort is shown in Table 1. As noted in Table 1, all preliminary runs were conducted using Type A Peabody coal. Five of the preliminary runs were conducted at the 100 MW load level representing the maximum gas flow conditions. A sixth preliminary run was made at the 35 MW load level. In these preliminary runs, excess air was varied from 115% to 145%. One preliminary run was made with soot blowers in operation to measure the maximum fly ash dust loading of the system.

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TABLE 1

TEST SCHEDULE FOR PRELIMINARY MEASUREMENT SUBTASK

DATE	TEST CONDITIONS	*MEASUREMENTS	REMARKS
(9/28) (9/29)	100 MW Load 115% Excess Air Coal Type A No Soot Blowing	● Temperature & Velocity Traverse at Economizer ● Orsat & Moisture Content at Economizer ● 40-point mass loading at front duct of air heater (ports 1 and 2)	Two days were required to conduct the test, due to time necessary for test preparation
9/30	100 MW Load 125% Excess Air Coal Type A No Soot Blowing	● Economizer Measurements same as above ● 40-point mass loading at front duct of air heater (ports 1 and 2) ● Velocity Survey of air heater back duct (ports 3 and 4)	
10/1	100 MW Load 125% Excess Air Coal Type A No Soot Blowing	● Economizer Measurements same as above ● 40-point mass loading at back duct of air heater (ports 3 and 4) ● Velocity Survey of air heater front duct (ports 1 and 2)	

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*All tests also include static pressure measurements, moisture content, and Orsat analysis for O_2 and CO_2

TABLE 1 (CONTINUED)

TEST SCHEDULE FOR PRELIMINARY MEASUREMENT SUBTASK

DATE	TEST CONDITIONS	MEASUREMENTS	REMARKS
10/5	100 MW Load 125% Excess Air Coal Type A Soot Blowing over period of test	• Economizer Measurements same as above • 40-point mass loading at back duct of air heater (ports 3 and 4)	Test to show effect of soot blowing (i.e., maximum fly-ash concentrations)
10/6	100 MW Load 125% Excess Air Coal Type A No Soot Blowing	• Economizer Measurements same as above • 2-separate single point mass loading measurements at back duct of air heater • Velocity Survey of air heater front duct and half of rear duct	Test to show effectiveness of single or ten-point mass loading measurement for subsequent tests
10/8	35 MW Load 145% Excess Air Coal Type A No Soot Blwoing	• Economizer Measurements same as above • 40-point mass loading at back duct of air heater	Test to show lowest extreme in gas flow and mass loading

The preliminary measurements conducted at the air heater on 10/6/71 were intended to provide a comparison between (1) a 40-point, 2-probe traverse of the rear duct (ports 3 and 4) and (2) a 10-point, single probe traverse of half of the rear duct (port 4) with (3) a single point, single probe sample from the rear duct (port 3, port 4).

From the results of this test, it was determined that the best method for measuring grain loading at location 2 would consist of a 20-point, 2-probe traverse in one-half of each duct (a total of 40 points). The halves selected are to be varied for the range of test conducted at each load factor to insure thorough sampling of the total duct.

A complete summary of the results of the preliminary measurements effort is provided in Appendix A.

MAIN MEASUREMENT PROGRAM

The main measurement program was initiated on November 8, 1971 following the completion of the preliminary measurement effort, and the completion of all required facility modifications (ports, sheds, and stack access platform).

A summary of the Baseline test conditions is presented in Table 2. As noted in Table 2, four load levels were examined in the tests: 100 MW, 75 MW, 50 MW, and 35 MW.

The four fuel types shown in Table 2 included Type A Peabody Coal (approximately 2.7 lbs S/10^6 BTU), Type B Freeman Coal (approximately 1.6 lbs S/10^6 BTU), Type C Coal, a mixture of Freeman Coal and Natural Gas (approximately 1.0 lbs S/10^6 BTU), and Type D metallurgical coal (source location undefined, sulfur content approximately 1.0 lbs S/10^6 BTU).

Two levels of soot blowing were investigated - no soot blowing and maximum soot blowing. However, on one test early in the series, an intermediate level of soot blowing was examined.

Three levels of excess air were examined as shown in Table 1 - minimum excess air, normal excess air, and maximum excess air.

TABLE 2

SUMMARY OF BASELINE TEST CONDITIONS

TEST NUMBER	DATE	LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR
11	NOV 8	100 MW	A	NO	NORMAL
9	NOV 9	100 MW	A	NO	MINIMUM
8	NOV 10	100 MW	A	NO	MAXIMUM
12	NOV 11	100 MW	A	YES*	NORMAL
7	NOV 12	100 MW	A	YES	NORMAL
6	NOV 15-16	100 MW	B	NO	NORMAL
1	NOV 14-15	75 MW	B	NO	NORMAL
18	NOV 16-17	50 MW	B	NO	NORMAL
13	NOV 17-18	35 MW	B	NO	NORMAL
4	NOV 18-19	75 MW	A	NO	MINIMUM
5	NOV 21-22	75 MW	C	NO	NORMAL
10	NOV 22-23	100 MW	C	YES	NORMAL
20	NOV 23-24	50 MW	C	NO	NORMAL
2	NOV 29-30	75 MW	A	NO	NORMAL
3	NOV 30-DEC 1	75 MW	A	NO	MAXIMUM
17	DEC 1-2	50 MW	A	YES	NORMAL
19	DEC 2-3	50 MW	A	NO	MAXIMUM
21	DEC 3-4	35 MW	A	NO	NORMAL
14	DEC 6-7	50 MW	A	NO	NORMAL
15	DEC 7-8	50 MW	A	NO	MINIMUM
22	DEC 8-9	75 MW	D	NO	NORMAL

*Reduced level of soot blowing

TEST OPERATING PROCEDURES

Of the 21 tests in the main measurement program, the first five tests were performed during the normal day shift (approximately 8:00 a.m. to 4:00 p.m.). The remaining tests were conducted during the evening shift (approximately 12:00 a.m. to 8:00 a.m.), in order to minimize the interference with higher-load daytime operations. In all cases, test personnel were on-site for a period of 1-2 hours preceding the start of the test. During this pre-test period, filters in the sampling lines were cleaned and preheated, sampling probes were inserted in the ports, and the instrumentation systems were calibrated.

Approximately one hour before the test, boiler controls were adjusted to provide the required excess air and power settings. Excess air was determined by MITRE gas measurements, and interative adjustments were made until the desired level was reached. The boiler system was then allowed to stabilize. When the system was stabilized and no variations in power level and excess air were observed, test personnel were notified to start their respective assignments.

Assignments for the various test personnel varied somewhat for the specific tests, but in general the following data collection efforts were carried out:

1. Key steam generator operating parameters were recorded from the control room instrumentation and from various gauges on the steam generator. These readings were entered in an "Operating Conditions Log," generally on an hourly basis.
2. Samples of coal were obtained from each of the four coal mills using the cyclone samplers and the techniques described in the test plan. Ash samples were also taken from the furnace bottom and from the air heater and mechanical collector. The coal samples and the ash samples were obtained over the period of test operation

(8-10 hours) and blended at the conclusion of the test so as to form single representative one quart samples.

3. Data log tapes were generated (using the steam generator control computer) and "printouts" were developed from the tapes on an hourly basis.
4. Relative humidity measurements were taken on an hourly basis at the forced draft fan inlet using a sling psychrometer.
5. The continuous measurement instrumentation system was placed in operation at location 1 and location 2. Strip charts and digital output derived from the system were collected and logged at the conclusion of the test.
6. Gas samples were taken manually at location 1 and location 3; grain loading samples were taken at location 2 and location 3 as required for the specific test.
7. On-site calculations were made with the programmable calculator as described in the Test Plan.

Data from all of the above efforts were collected at the conclusion of each test, marked with the appropriate identification number, noted in the Master Data Log, and filed in a data test package (in accordance with the data management procedures described in the Test Plan).

CONTINUOUS MEASUREMENT SYSTEM

The MITRE continuous measurement system consisted of a number of gas sensors, velocity, pressure, and temperature transducers, a sample handling system to condense water vapor, strip chart recorders, and digital tape printers, and the necessary filters, probes, heated lines, and valves to control the flow of flue gases to the sensors. The system was designed to clean sampling line filters on a periodic basis by "blowback" with pressurized air; and to maintain calibration of the sensors by the periodic introduction of known concentrations of test gases into the system.

The continuous measurement system was constructed in two major sections, each section separately contained in a shed enclosure for environmental protection. The first section of the system was located at the economizer of the steam generator (measurement location 1). This portion of the system consisted of a water vapor condenser, a sulfur dioxide analyzer, an oxygen analyzer, and a velocity measurement system with strip chart output. A temperature monitoring system with a digital output was also located at this position. The second section of the continuous measurement system was located in a shed mounted on the roof of the steam generator building at a position opposite the midpoint of the stack. At this location, the system included a water vapor condenser, a sulfur dioxide analyzer, an analyzer for nitrogen dioxide and nitrogen oxide, a carbon dioxide analyzer, a carbon monoxide analyzer, a hydrocarbon analyzer, an oxygen analyzer, and a velocity measurement system with strip chart output. The system at this location also included a particulate monitoring system with digital output.

MANUAL MEASUREMENTS

Manual measurements were made during the Baseline Test program by the MITRE test team and by a stack sampling subcontractor (Midwest Research Institute).

The measurements by the MITRE test team included the observation and recording of all major gauge board readings from the steam generator control room, observation and recording of coal scale readings, measurement of atmospheric pressure, and measurement of moisture content of air at the forced draft fan inlet to the steam generator. The efforts of the MITRE test team also included the collection of coal and ash samples at various points in the steam generator.

The manual measurements by the Midwest Research Institute team included the collection of gas samples at the economizer (measurement location 1) and midway in the stack (measurement location 3). Particulate samples were also obtained by the Midwest Research Institute team at the air heater (measurement location 2) and midway in the stack, Orsat analyzers of the flue gas at the air heater were also conducted by Midwest Research Institute.

MEASUREMENT PARAMETERS

The parameters monitored at each of the three measurement locations are indicated in Table 3. The parameters shown as being monitored by the continuous measurement system were normally measured on all of the twenty-one tests. The manual measurements shown in Table 3, in most cases, were varied for specific tests.

As mentioned previously, the parameters monitored by the MITRE test team included the observation and recording of all major gauge board readings from the control room, observation and recording of coal scale readings, measurement of atmospheric pressure, and measurement of the moisture content of the air at the forced draft fan inlet to the steam generator. A listing of these parameters is provided in Table 4.

Information was also obtained from the steam generator control system in the form of hourly printouts from the control system computer. Key temperatures, pressures, flow rates, and electrical measurements were recorded on these data log printouts, as well as several calculated values (i.e., boiler efficiencies, integrated fuel flows).

MEASUREMENT LOCATIONS

The three locations utilized in the Baseline Measurement included: location 1 - the flue section between the secondary superheater and economizer, location 2 - in the inspection window area between the upper and lower sections of the air preheater ducting, and location 3 - midway in the stack.

The first of these locations, prior to the economizer, was selected to provide data at the relatively high temperatures corresponding to the inlet to a Cat-Ox system designed for installation in new steam generators. Four ports were in existence at this location. Three

TABLE 3

BASELINE MEASUREMENT PARAMETERS (CONTINUOUS AND MANUAL MEASUREMENTS)

	CONTINUOUS MEASUREMENT SYSTEM	MANUAL MEASUREMENTS
LOCATION 1 (PRIOR TO ECONOMIZER)	O_2	SO_3
	SO_2	SO_2
	TEMPERATURE, AIR HEATER, AIR IN	NO_x
	TEMPERATURE, AIR HEATER, AIR OUT	CO
	TEMPERATURE, AIR HEATER, GAS IN	CO_2
	TEMPERATURE, AIR HEATER, GAS OUT	ORSAT O_2
	TEMPERATURE, AIR ENTERING FORCED DRAFT FAN	ORSAT CO_2
	HUMIDITY, AIR ENTERING FORCED DRAFT FAN	ORSAT CO
	PITOT TUBE ΔP STATIC PRESSURE FLUE GAS TEMPERATURE } GAS FLOW MEASUREMENT	
LOCATION 2 (BETWEEN UPPER AND LOWER TUBES OF AIR HEATER)	(NO CONTINUOUS MEASUREMENT AT THIS LOCATION)	GRAIN LOADING
		PARTICULATE SIZE DISTRIBUTION
		ELEMENTAL ANALYSIS OF PARTICLES
		BOUND CONSTITUENTS ON PARTICLES
		PITOT TUBE ΔP STATIC PRESSURE FLUE GAS TEMPERATURE } GAS FLOW MEASUREMENT

TABLE 3 (CONCLUDED)

BASELINE MEASUREMENT PARAMETERS (CONTINUOUS AND MANUAL MEASUREMENTS)

	CONTINUOUS MEASUREMENT SYSTEM		MANUAL MEASUREMENTS	
LOCATION 3 (MIDWAY IN STACK)	PITOT TUBE ΔP	GAS FLOW MEASUREMENT	SO_3	ORSAT O_2
	STATIC PRESSURE		SO_2	ORSAT CO_2
	FLUE GAS TEMPERATURE		NO_x	ORSAT CO
	GRAIN LOADING		CO	H_g VAPOR
	SO_2		CO_2	
	NO_x		GRAIN LOADING	
	O_2		PARTICLE SIZE DISTRIBUTION	
	HYDROCARBON		ELEMENTAL ANALYSIS OF PARTICLES	
	CO		BOUND CONSTITUENTS ON PARTICLES	
	CO_2		PITOT TUBES ΔP	GAS FLOW MEASUREMENT
			STATIC PRESSURE	
			FLUE GAS TEMPERATURE	
OTHER LOCATIONS	(NO CONTINUOUS MEASUREMENTS AT OTHER LOCATIONS)		PROXIMATE & ULTIMATE ANALYSIS OF COAL	
			ELEMENTAL ANALYSIS OF COAL	
			ELEMENTAL ANALYSIS OF BOTTOM ASH	
			ELEMENTAL ANALYSIS OF AIR HEATER ASH	
			ELEMENTAL ANALYSIS OF MECHANICAL SEPARATOR ASH	
			PROXIMATE ANALYSIS OF PYRITE REJECTS	
			PROXIMATE ANALYSIS OF BOTTOM ASH	
			PROXIMATE ANALYSIS OF AIR HEATER ASH	
			PROXIMATE ANALYSIS OF MECHANICAL SEPARATOR ASH	
			ELEMENTAL ANALYSIS OF PYRITE REJECTS	

TABLE 4

BASELINE MEASUREMENT PARAMETERS
(STEAM GENERATOR GAUGE BOARD READINGS)

- CONDENSER VACUUM (PSI)
- ATM PRESS. AT AIR INTAKE (IN OF H_g)
- HUMIDITY AT AIR INTAKE (%)
- (INTEGRATOR LOG READINGS)
  - BOILER STEAM FLOW (LBS./HR.)
  - BOILER FW FLOW (LBS./HR.)
  - BEVEL GAS FLOW (LBS./HR.)
  - SH SPRAY FLOW (4TH FLOOR) (LBS./HR.)
  - RH SPRAY FLOW (4TH FLOOR) (LBS./HR.)
  - 'A' COAL SCALE (CLICKS)
  - 'B' COAL SCALE (CLICKS)
  - 'C' COAL SCALE (CLICKS)
  - 'D' COAL SCALE (CLICKS)
- (GAUGE BOARD READINGS)
  - (UTILITIES SECTION)
    - CONDENSER PRESSURE (IN OF H_g)
  - (FEEDWATER & STEAM SECTION)
    - DRUM PRESS (PSI)
    - D.C. HEATER PRESS (PSI)
    - 4A BFP DISCH (PSI)
    - 4B BFP DISCH (PSI)
    - BLR FEED HDR (PSI)
    - FW FLOW TO BLR (LBS./HR.)
    - MAINSTREAM TEMP (°F)
    - THROTTLE PRESSURE (PSI)
    - HOT REHT TEMP. (°F)
    - COLD REHT TEMP. (°F)
    - 4A RH SPRAY VALVE (%)
    - 4B RH SPRAY VALVE (%)
    - BURNER TILT (%)
    - 4A SH SPRAY VALVE (%)
    - 4B SH SPRAY VALVE (%)
  - AIR & FUEL SECTION
    - 4A FD FAN DISCH. (IN OF H_2O)
    - 4B FD FAN DISCH. (IN OF H_2O)
    - FURN. DRAFT (IN OF H_2O)
    - RHTR. OUTLET (IN OF H_2O)
    - SUPHTR OUTLET (IN OF H_2O)
    - ECON. OUT (IN OF H_2O)

TABLE 4 (CONCLUDED)

BASELINE MEASUREMENT PARAMETERS
(STEAM GENERATOR GAUGE BOARD READINGS)

4A AIR HEATER OUT (IN OF H_2O)
4B AIR HEATER OUT (IN OF H_2O)
4A DUST COL. OUT (IN OF H_2O)
4B DUST COL. OUT (IN OF H_2O)
STACK INLET (IN OF H_2O)
FLUE GAS O_2 (%)
STEAM FLOW (LBS./HR.)
AIR FLOW (LBS./HR.)
UNIT GROSS GEN. (MW)
AH 4A GAS OUT (°F)
AH 4B GAS OUT (°F)
4A MILL (AMPS)
4B MILL (AMPS)
4C MILL (AMPS)
4D MILL (AMPS)
4A ID FAN (AMPS)
4B ID FAN (AMPS)
4A FD FAN (AMPS)
4B FD FAN (AMPS)
4A MILL FEEDER (%)
4B MILL FEEDER (%)
4C MILL FEEDER (%)
4D MILL FEEDER (%)
GAS VALVE (%)
4A ID FAN SPEED (RPM)
4B ID FAN SPEED (RPM)
4A ID FAN DAMPER (%)
4B ID FAN DAMPER (%)
4A FD FAN SHTOFF DAMP. (%)
4B FD FAN SHTOFF DAMP. (%)
4A FD FAN VANES (%)
4B FD FAN VANES (%)
FUEL AIR RATIO SET PT. (%)

additional ports were constructed to bring the total to seven ports at this location. Four measurement points were selected for each port so as to provide the proper number and distribution of measurement points in accordance with ASTM Standard D2928-71. "Standard Method for Sampling Stacks for Particulate Matter." The numbers assigned to the ports and points at location 1 and the associated dimensions are shown in Figure 1.

Location 2, between the upper and lower sections of the air preheater, was selected as representative of a lower temperature condition prior to any existing or planned flue gas treatment system. This location was selected as the best available point prior to the mechanical collector for the measurement of particulate. The ports and sampling points for this location are shown in Figure 2. At location 2 there are two identical ducts, only one of which is shown in Figure 2. The twenty sampling points which are shown directly in the line with the ports were reached with a seventeen-foot sampling probe. The twenty sampling points which are not directly in line with the ports were reached by an "offset" modification attached to the seventeen-foot probe.

Location 3, approximately 135 feet above the foundation of the 250-foot stack, was selected to provide a condition representative of the flue gas emitted to the atmosphere (and, in this instance, conditions which will be seen at the reheat Cat-Ox/steam generator interface). Access at this location was achieved by installing a platform around the stack with a walkway to the adjacent power station roof. Four ports were installed in the stack at this location as shown in Figure 3. Nine measurement points were selected for each port to provide the proper number and distribution of measurement points consistent with ASTM Standard D2928-71.

MANUAL SAMPLING SCHEDULE

Table 5 provides a summary of the test conditions followed in the Baseline Measurement program. Table 5 also presents a summary of the schedule followed in obtaining manual samples at the three measurement locations.

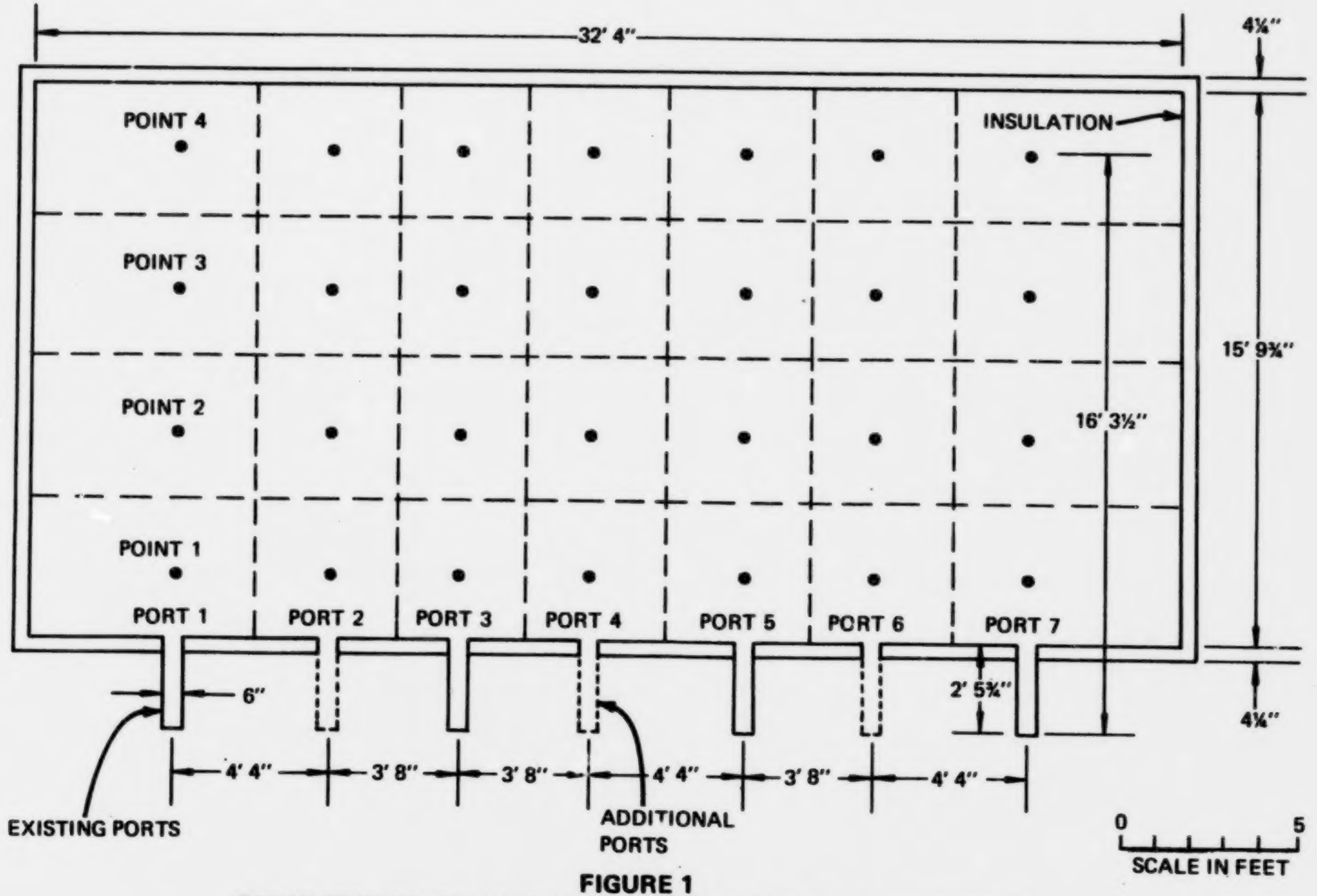
32' 4"
4¼"
15' 9¾"
4¼"
INSULATION
16' 3½"
POINT 4
POINT 3
POINT 2
POINT 1
PORT 1
PORT 2
PORT 3
PORT 4
PORT 5
PORT 6
PORT 7
6"
2' 5¾"
4' 4"
3' 8"
3' 8"
4' 4"
3' 8"
4' 4"
EXISTING PORTS
ADDITIONAL PORTS
0
5
SCALE IN FEET

FIGURE 1
CROSS SECTION OF DUCT AT LOCATION 1, PRIOR TO ECONOMIZER, SHOWING MEASUREMENT POINTS

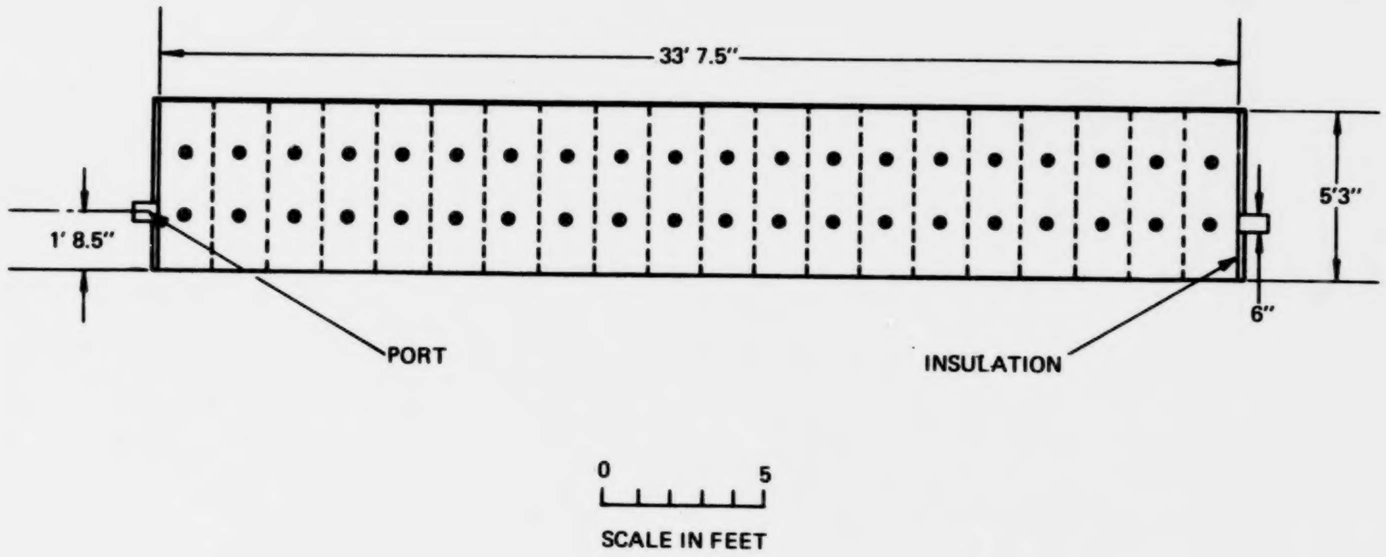
33' 7.5"
5'3"
1' 8.5"
6"
PORT
INSULATION
0
5
SCALE IN FEET

FIGURE 2
CROSS SECTION OF DUCT AT LOCATION 2, IN AIR PREHEATER, SHOWING MEASUREMENT POINTS

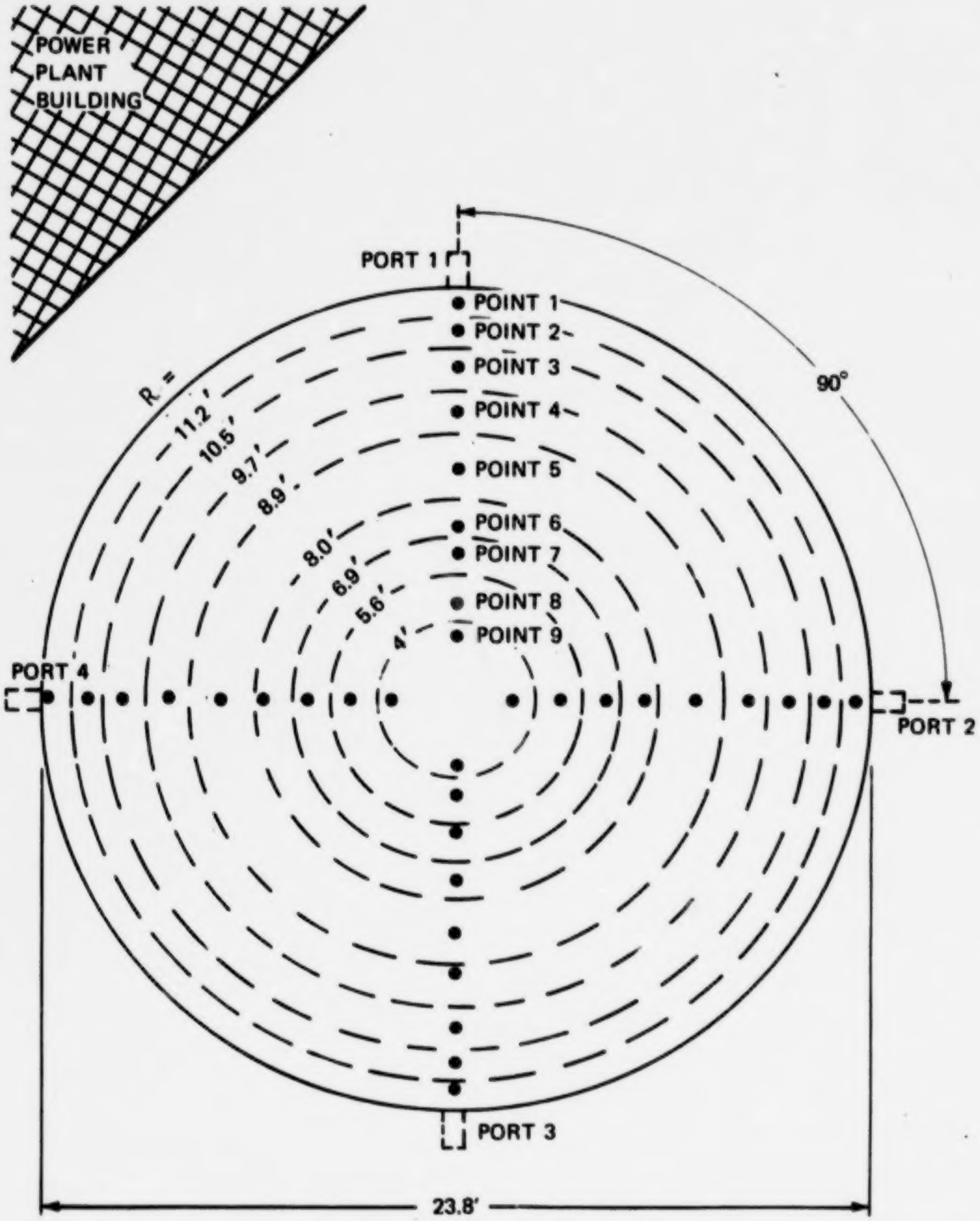
POWER
PLANT
BUILDING
PORT 1
POINT 1
POINT 2
POINT 3
POINT 4
POINT 5
POINT 6
POINT 7
POINT 8
POINT 9
90°
R =
11.2'
10.5'
9.7'
8.9'
8.0'
6.9'
5.6'
4'
PORT 4
PORT 2
PORT 3
23.8'

FIGURE 3
CROSS SECTION OF DUCT AT POINT 3, IN STACK,
SHOWING MEASUREMENT POINTS

MITRE TEST NUMBER	DATE	LOAD FACTOR (%)	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE
11	NOV. 8	100	A	NO	NORM.	NORM.
4	NOV. 9	100	A	NO	MIN.	NORM.
8	NOV. 10	100	A	NO	MAX.	NORM.
12	NOV. 11	100	A	YES**	NORM.	NORM.
7	NOV. 12	100	A	YES	NORM.	NORM.
6	NOV. 13-16	100	[illegible]	NO	NORM.	NORM.
[illegible]	NOV. 14-15	[illegible]	[illegible]	NO	NORM.	NORM.
18	NOV. 16-17	50	[illegible]	NO	NORM.	NORM.
13	NOV. 17-18	75	[illegible]	NO	NORM.	NORM.
[illegible]	NOV. 18-19	[illegible]	[illegible]	NO	MIN.	NORM.
[illegible]	NOV. 21-22	75	[illegible]	[illegible]	NORM.	NORM.
[illegible]	NOV. 22-23	100	[illegible]	YES	NORM.	NORM.
[illegible]	NOV. [illegible]	50	[illegible]	[illegible]	NORM.	NORM.
[illegible]	NOV. 29-30	75	A	NO	MAX.	NORM.
3	NOV. 30 - DEC. 1	75	A	NO	MAX.	NORM.
17	DEC. 1-2	50	A	YES	NORM.	NORM.
19	DEC. 2-3	50	A	YES	MAX.	NORM.
21	DEC. 3-4	75	A	NO	NORM.	NORM.
[illegible]	DEC. 6-7	50	A	NO	NORM.	NORM.
15	DEC. 7-8	50	A	NO	MIN.	NORM.
23	DEC. 8-9	75	B	NO	NORM.	NORM.
TOTAL NUMBER OF SAMPLES						

* LOCATIONS 1 AND 2

**REDUCED LEVEL OF SOOT BLOWING

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A

BOUND CONSTITUENTS (PHOTOELECTRON SPECTROSCOPY)		MERCURY		BOUND CONSTITUENTS				ELEMENTAL ANALYSIS OF COAL	ELEMENTAL ANALYSIS OF BOTTOM ASH	ELEMENTAL ANALYSIS OF AIR HEATER ASH	ELEMENTAL ANALYSIS OF MECHANICAL SEPARATOR ASH	ULTIMATE AND PROXIMATE ANALYSIS OF COAL	PROXIMATE ANALYSIS OF PYRITES	PROXIMATE ANALYSIS OF SLAG	PROXIMATE ANALYSIS OF AIR HEATER ASH	PROXIMATE ANALYSIS OF MECHANICAL SEPARATOR ASH	ELEMENTAL ANALYSIS OF PULVERIZER REJECTS
				SO_2 & SO_3		HYDROCARBONS											
2	3	1	3	2	3	2	3										
												1				1	
												1					
1	1			1	1	1	1					1			1	1	
												1					
												1					
												1			1	1	
				1	1	1	1	1	1	1	1	1	1	1	1	1	1
								1			1	1			1	1	
												1			1	1	
												1					
1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1
												1	1	1	1	1	
								1				1			1	1	
												1					
								1	1		1	1	1	1		1	1
1	1			1	1	1	1					1					
			1									1					
			1									1	1	1	1	1	
			1					1				1					
												1					
1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	4		3	5	5	5	5	7	4	3	4	21	6	6	10	12	4

PROXIMATE ANALYSIS OF SLAG	PROXIMATE ANALYSIS OF AIR HEATER ASH	PROXIMATE ANALYSIS OF MECHANICAL SEPARATOR ASH	ELEMENTAL ANALYSIS OF PULVERIZER REJECTS
		1	
	1	1	
	1	1	
1	1	1	1
	1	1	
	1	1	
1	1	1	1
1	1	1	
	1	1	
1		1	1
1	1	1	
1	1	1	1
6	10	12	4

TABLE 5
SUMMARY OF BASELINE
TEST MANUAL MEASUREMENT

As noted in Table 5, emphasis was placed on the measurement of SO_2, NO_x, CO, and CO_2 concentrations, and in the determination of mass loading. These measurements were originally scheduled for all twenty-one tests for correlation against the measurements obtained from the continuous measurement instrumentation system. The gas measurements were subsequently rescheduled as shown in Table 5 so as to provide the maximum coverage of test conditions with the resources allocated for the program. Mass loading samples were obtained for all of the tests, since it was anticipated that the portion of the continuous measurement system that measured this parameter (β-tape sampling) would not be operable early in the test schedule.

Particle size distributions were originally scheduled for each fuel type (A, B, C, and D) with an extra sample scheduled for fuel type A. However, difficulties were encountered on the B fuel test (test No. 6) and an insufficient sample was obtained for the measurement.

Elemental analysis of the fly ash was scheduled for each of the fuel types with extra samples scheduled for two 50 MW tests (test 17 and test 19) to note any possible effect from soot blowing.

Bound constituents were determined (both by photoelectron spectroscopy and chemical analysis) for tests representing the four fuel types, with an extra sample scheduled for fuel type A.

Ultimate and proximate analysis of coal was scheduled for all of the twenty-one tests, since these results were required for the calculation of efficiencies and for other material balances.

Analyses of the ash at the various locations within the steam generator system were scheduled as shown in Table 5 so as to provde a maximum of information on a materials balance within the system.

MANAGEMENT OF DATA

The data management system used during the Baseline Measurement test included a uniform labeling system for all data samples, and log sheets forwarded from the test site.

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The purpose of the labeling system was to provide full and manageable control of all data. Fourteen items were specified to be included on the label; however, not all data, samples, or logs required all the items. The fourteen items included:

1. Label ID: XXYYZZ
   (Where XX = type sample, i.e., CS = coal sample, PA = pit ash sample, etc.; XY = test number, and ZZ = consecutive sample number)
2. Parameters Measured
3. Date: (Day/Month/Year)
4. Location
5. Port of Measurement
6. Depth of Probe (inches)
7. Time of Samples (Time Range for Strip Charts)
8. Names of Data Collector
9. Name of I.P. Shift Supervisor
10. Fuel Type (A, B, C, or D)
11. Load Factor (MW)
12. Excess Air Ratio (Normal, Max, or Min)
13. Soot Blowers (Yes or No)
14. Burner Angle (Normal, Max, Min).

In addition to the uniform labeling system, a data management log was used to verify the location and status of the various data packages. This log, which served as the primary control log for all data packages, was completed by a member of the MITRE test team at the completion of each day's test run. The log included the following major entries:

1. Test Number and Date
2. Expected Variables
3. Coal and Refuse Sampling
4. Temperature Monitoring
5. Continuous Flue Gas Monitoring
6. Manual Flue Gas Sampling

7. Operating Conditions
8. On-Site Calculations Performed
9. Personnel
10. Test Director Notes.

A full description of the complete data management log is provided in Appendix II.

After the log sheet was completed for the test run, it was shipped along with the continuous measurement data to the MITRE Washington facility. The log sheet was then maintained in a MITRE control log in which MITRE personnel noted the receipt and condition of the other data packages associated with that day's test run.

After the data were received and logged at the MITRE Washington facility, they were then stored in a central archive with controlled access. These data were stored in labeled fiberboard file boxes (one box per test day) under the custody and control of the MITRE Task Leader.

SECTION IV

DATA PROCESSING

This section describes the procedures followed by the MITRE test team in processing the data output from the continuous measurement system, steam generator operating data, and data obtained from the manual measurements made by the Midwest Research Institute. Information is also provided in this section on the data reduction system developed for MITRE's IBM 360/50 computer, and on the structure and contents of the data base as used for baseline test calculations.

CONTINUOUSLY MEASURED DATA

The data output from MITRE's continuous measurement system consisted of strip chart outputs from the sulfur dioxide analyzer at the economizer, the oxygen analyzer at the economizer, the economizer velocity measurement system, the sulfur dioxide analyzer at the stack, the stack analyzer for nitrogen dioxide and nitrogen oxide, the carbon dioxide analyzer at the stack, the carbon monoxide analyzer at the stack, the stack hydrocarbon analyzer, the oxygen analyzer at the stack, and the stack velocity measurement system. The continuous measurement system data output also included the digital tape output from the temperature monitoring system at the economizer, and strip chart output from a continuous recording barometer.

Data from the strip charts were transcribed at hourly intervals based on a visual averaging of the data over a one-hour period. If gaps in the chart prevented transcription for a particular hour, the average value for the test was substituted. Since the instruments were calibrated prior to each test and were adjusted during the test as required, the transcribed values needed only to be corrected for zero level offset.

The transcription process was straightforward for all gases except NO_x. Here, the analyzer provided both NO_2 and $NO + NO_2$ values. The NO_2 data, being within instrumental noise, were assumed to be zero and the $NO + NO_2$ data were transcribed as NO only.

STEAM GENERATOR OPERATING DATA

The steam generator operating data recorded for the Baseline Test included all major gaugeboard readings, coal scale readings, atmospheric pressure, and moisture content of the air at the inlet to the forced draft fan as recorded manually on the operating conditions log sheet. These data were recorded at approximately hourly intervals throughout the duration of the test. Additional data in the form of key temperatures, pressures, and flow rates were also obtained on an hourly basis in the form of printouts from the control system computer. No further transcription was required of the steam generator operating data beyond the original log sheet entries and the printouts, with the exception of the fuel consumption rates.

The total coal consumption was obtained from the integrator dial on the coal scales which indicated the number of 400-pound units supplied. To obtain the consumption rate the dial reading at the beginning of a test was subtracted from that at the end of the test, multiplied by 400, and divided by the time interval. Consumption rates were computed for each of the four coal scales and added to obtain the total coal consumption rate for the test.

The gas consumption rate was computed in a similar manner. Integrator meter values indicating 10^4 cubic foot units were used to calculate an average value for the test. Gas pressure and temperature test averages were also computed.

MANUAL MEASUREMENTS

Data obtained by the Midwest Research Institute as part of their manual measurement program were entered directly on series of MRI field test forms. Copies of these completed field test forms were forwarded to MITRE; however, no further transcription of the data was performed by MITRE. The data on the field test results were utilized along with the analytical laboratory results to provide the required information on grain loadings, gas concentrations, particulate mass flows, and gas mass flows. All calculations required to provide this information were performed by the Midwest Research Institute using standard computational procedures.

Data sheets reporting the results of analysis of natural gas samples (as analyzed by MRI and the Illinois Geological Survey) were also received at MITRE and utilized without further transcription.

DATA REDUCTION SYSTEM

As an aid to the analysis of baseline test results, a data reduction system was developed for the IBM 360/50 computer at the MITRE/Washington facility. The following discussion describes the structure of this system and gives an inventory of the data base contents.

Data Reduction System Structure

The data reduction system consists of a data base of measurement values and a PL/1 computer program. The data base, although large in terms of manual processing, is relatively small from a computer standpoint and does not require any specialized storage techniques or access methods. It consists of unit records (i.e., card or card images on tape) accessed in a conventional sequential fashion. Each record consists of measurements of a single type identified in the following manner:

1. Type of Data
    - 1 - Coal Composition
    - 2 - Gas Composition
    - 3 - Flue Gas Composition
    - 4 - Refuse Characteristics
    - 5 - Fuel Composition
    - 6 - Air Heater Temperature
    - 7 - Ambient Conditions
    - 8 - Electrical Power
    - 9 - Operating Conditions
    - A - Miscellaneous Constants
    - B - Flow Characteristics
    - C - Duct Characteristics

2. Test Number
3. Date
4. Time
5. Location (does not apply to some data types)
    1 - Economizer
    2 - Air Heater
    3 - Stack
6. Measurement Method (does not apply to some data types)
    0 - Manual
    X - Manual (Orsat)
    1 - Continuous (MITRE Instrumentation)
    2 - Continuous (IPC automatic data log)

The basic record format is given in Table 6. Detailed formats for each data type are given in Tables 7 through 18.

The computer program to process the data has been designed as a main program "shell" into which modules for the individual calculations can be inserted. This main program reads the system control cards and accesses individual records in the data base. Each module selects the specific data values that are required for its calculations, performs these calculations, and prints the results. If some of the required data items cannot be found, the module will omit those calculations which depend upon the missing items, but will perform the remainder of its calculations. In addition, data items of a single type which have the same test number, time, and data may reside on physically separate records as long as they are placed in the proper columns. This flexibility simplifies data transcription since measurements which should reside in the same record may not be available at the same time or recorded on the same source document. The modules being implemented are as follows:

1. Efficiency Calculation
2. Excess Air Calculation
3. Volume and Mass Flow Calculations for Flue Gases

Table 19 summarizes the characteristics of these modules.

TABLE 6

BASIC RECORD FORMAT

COLUMNS	DESCRIPTION
1	Type of Data
2 - 3	Test Number
4 - 9	Date
4 - 5	Day
6 - 7	Month
7 - 9	Year
10 - 13	Time (24-hour clock)
14	Location
15	Measurement Method
16 - 20	Measurement Values
21 - 25	
26 - 30	
31 - 35	
36 - 40	
41 - 45	
46 - 50	
51 - 55	
56 - 60	
61 - 65	
66 - 70	
71 - 75	
76 - 80	

TABLE 7

COAL COMPOSITION RECORD FORMAT

COLUMNS	DESCRIPTION
1	"1"
2 - 9	Identification (Test Number and Date)
10 - 15	Unused
16 - 20	Ash Fraction
21 - 25	Carbon Fraction
26 - 30	Hydrogen Fraction
31 - 35	Nitrogen Fraction
36 - 40	Sulfur Fraction
41 - 45	Moisture Fraction
46 - 50	Heat Content (BTU/lb.)

TABLE 8

GAS COMPOSITION RECORD FORMAT

COLUMNS	DESCRIPTION
1	"2"
2 - 9	Identification (Test Number and Date)
10 - 15	Unused
16 - 20	Unused
21 - 25	Carbon Fraction
26 - 30	Hydrogen Fraction
31 - 35	Nitrogen Fraction
36 - 40	Sulfur Fraction
41 - 45	Unused
46 - 50	Heat Content (BTU/lb.)
51 - 56	Specific Gravity

TABLE 9

FLUE GAS COMPOSITION RECORD

COLUMNS	DESCRIPTION
1	"3"
2 - 15	Identification (Test Number, Date, Time, Location, Method)
16 - 20	CO_2 Fraction*
21 - 25	O_2 Fraction*
26 - 30	CO Fraction*
31 - 35	N_2 Fraction*
36 - 40	SO_2 Fraction*
41 - 45	Hydrocarbon Fraction*
46 - 50	Hydrocarbon Molecular Weight
51 - 55	Hydrocarbon Heating Value (BTU/ft^3)
56 - 60	NO Fraction*
61 - 65	NO_2 Fraction*

* A fraction value >1 implies that the units are ppm.

TABLE 10

REFUSE CHARACTERISTICS RECORD FORMAT

COLUMNS	DESCRIPTION
1	"4"
2 - 9	Identification (Test Number, Date)
10 - 15	Unused
16 - 20	Pit Ash Heating Value (BTU/lb.)
21 - 25	Fly Ash Heating Value (BTU/lb.)
26 - 30	Flue Gas Particulate Mass Flow Rate (lb./hr.)

TABLE 11

FUEL CONSUMPTION RECORD FORMAT

COLUMNS	DESCRIPTION
1	"5"
2 - 13	Identification (Test Number, Date, Time)
14 - 15	Unused
16 - 20	Coal Consumption Rate (lb/hr.) x 10^{-3}
21 - 25	Fuel Air Mixture Temperature (°F)
26 - 30	Gas Flow Rate (ft^3/hr. x 10^{-3})
31 - 35	Gas Pressure (lb/in^2)
36 - 40	Gas Temperature (°F)

TABLE 12

AIR HEATER TEMPERATURE RECORD FORMAT

COLUMNS	DESCRIPTION
1	"6"
2 - 13	Identification (Test Number, Date, Time)
14 - 15	Unused
16 - 20	Air Heater Entering Air Temperature (°F)
21 - 25	Air Heater Exit Gas Temperature (°F)

TABLE 13

AMBIENT CONDITIONS RECORD FORMAT

COLUMNS	DESCRIPTION
1	"7"
2 - 13	Identification (Test Number, Date, Time)
14	Unused
15	Identification (Method)
16 - 20	Ambient Temperature at Forced Draft Fan (°F)
21 - 25	Relative Humidity Fraction at Forced Draft Fan
26 - 30	Ambient Pressure at Forced Draft Fan (inches Hg.)

TABLE 14

ELECTRICAL POWER RECORD FORMAT

COLUMNS	DESCRIPTION
1	"8"
2 - 13	Identification (Test Number, Date, Time)
14 - 15	Unused
16 - 20	Pulverizer No. 1 Current (amperes)
21 - 25	Pulverizer No. 2 Current (amperes)
26 - 30	Pulverizer No. 3 Current (amperes)
31 - 35	Pulverizer No. 4 Current (amperes)
36 - 40	Forced Draft Fan No. 1 Current (amperes)
41 - 45	Forced Draft Fan No. 2 Current (amperes)
46 - 50	I. D. Fan No. 1 Current (amperes)
51 - 55	I. D. Fan No. 2 Current (amperes)

TABLE 15

OPERATING CONDITIONS RECORD FORMAT

COLUMNS	DESCRIPTION
1	"9"
2 - 13	Identification (Test Number, Date, Time)
14 - 15	Unused
16 - 20	Steam Flow (lb./hr. x 10^{-3})

TABLE 16

MISCELLANEOUS CONSTANTS RECORD FORMAT

COLUMNS	DESCRIPTION
1	"A"
2 - 9	Identification (Test Number, Date)
10 - 15	Unused
16 - 20	Air Heater Leakage Fraction

TABLE 17

FLOW CHARACTERISTICS RECORD FORMAT

COLUMNS	DESCRIPTION
1	"B"
2 - 15	Identification (Test Number, Date, Time, Location, Method)
16 - 20	Flue Gas Temperature (°F)
21 - 25	Duct Static Pressure (inches H_2O)
26 - 30	Flue Gas Velocity (ft/min.)

TABLE 18

DUCT CHARACTERISTICS RECORD FORMAT

COLUMNS	DESCRIPTION
1	"C"
2 - 13	Unused
14	Identification (Location)
15	Unused
16 - 20	Area (ft^2)

TABLE 19

COMPUTATION MODULES

NAME OF MODULE	REQUIRED DATA BASE RECORDS	PRINTED OUTPUT
EFFICIENCY	1, 2, 3, 4, 5, 6, 7, 8, 9, A	Net Efficiency Gross Efficiency Electrical Power Inputs Individual Losses Radiation Loss
EXCESS AIR	3	Excess Air Percentage
FLOW	3, 7, B, C,	For Each Flue Gas Constituent: Volume Flow (Actual) Volume Flow (Standard Conditions) Mass Flow

Contents of the Data Base

The previous discussion of the data reduction system described the data base with respect to its format and data storage capabilities. The following discussion will describe the data base as it was actually used for baseline test calculations. An inventory of all information contained in the present version of the data base is given, together with an indication of the data selected for the final computations. The data base itself is reproduced in Appendix C.

1. Coal Composition

   The data base contains the as-received ash, carbon, hydrogen, nitrogen, sulfur, moisture and heat value of the coal for all 21 tests as analyzed by Midwest Research Institute.

2. Gas Composition

   For the three tests which used natural gas the data base contains the as-received carbon, hydrogen, nitrogen, sulfur and heat value of the gas as well as specific gravity.

3. Flue Gas Composition

   Table 20 is an inventory of the flue gas measurements by location, measurement type and gas constituent. It also indicates which measurements were used in the final calculations. The manual and Orsat measurements consisted of a single test value or, in some cases, the average of two values. The continuous measurements consisted of hourly average values transcribed from MITRE strip charts. The column entries which appear on Table 20 and on Table 21 and 22 which are capital letters (C, M, and O) indicate whether, for these particular gases and at these locations, continuous, manual, or Orsat analysis results were used in the computations. Conversely, a lower case entry (c, m, and o) indicates where the data could not be used in the computation (incidences where data were suspect, or lacking because of equipment failure).

TABLE 20

FLUE GAS DATA INVENTORY FOR LOCATIONS 1, 2, AND 3

MITRE TEST NUMBER	LOCATION 1									LOCATION 2									LOCATION 3								
	O_2			CO_2			SO_2			O_2			CO_2			O_2			CO_2			SO_2			NO		
	M	C	O	M	C	O	M	C	O	M	C	O	M	C	O	M	C	O	M	C	O	M	C	O	M	C	O
11		C						C										O	m		O				M		
9		C		M				C				o			o			O	m		O				M		
8		C		M			m	C				o			o			O	m		O	M			M		
12		C		M			m	C				o			o			O	m		O	m	C		M		
7		C		M			m	C				o			o		C	o	m	C	o	m	C		m	C	
1		C		M			m	C				o			o		C	o	m	C	o	m	C		m	C	
6		C		M			m	C				o			o		C	o	m	C	o	m	C		m	C	
18		C		M			m	C				o			o		C	o	m	C	o	m	C		m	C	
13		C		M			m	C				o			o		C	o	m	C	o	m	C		m	C	
4		C	o	M		o	m	C				o			o		C	o	m	C	o	m	C		m	C	
5		C		M			m	C				o			o		C	o	m	C	o	m	C		m	C	
10		C		M			m	C				o			o		C	o	m	C	o	m	C		m	C	
20		C		M			m	C				o			o		C	o	m	C	o	m	C		m	C	
2		C		M			m	C				o			o		C	o	m	C	o	m	C		m	C	
3		C		M			m	C				o			o		C	o	m	C	o	m	C		m	C	
17		C		M			m	C				o			o		C	o	m	C	o		C		m	C	
19		C	o	M		o	m	C				o			o		C	o	m	C	o	m	C		M		
21		C		M			m	C				o			o		C	o	m	C	o	m	C		m	C	
14		C						C				o			o		C	o		C	o		C			C	
15		C						C				o			o		C	o		C	o					C	
22		C						C				o			o		C	o		C	o		C			C	

DATA USED IN COMPUTATION OF EFFICIENCY, VOLUME FLOW, AND MASS FLOW

C - CONTINUOUS (MITRE)
M - MANUAL
O - ORSAT

DATA NOT USED IN COMPUTATIONS

m - MANUAL
o - ORSAT

4. Fuel Consumption

   The data base contains the coal consumption rate, the fuel air mixture temperature (assumed fixed at 150°F) and the natural gas volume flow rates, pressures, and temperatures. These measurements were obtained from Illinois Power continuous monitoring instruments. Average values for each test were inserted into the data base.

5. Air Heater Temperatures

   Air input and gas output temperatures in the air heater were obtained on an hourly basis from both the Illinois Power automatic data log and the MITRE continuous measurements recorded on digital tape. Table 21 is an inventory of these measurements which indicates the data used in the computations.

6. Ambient Conditions

   The data base contains the average ambient temperature, relative humidity and barometric pressure for each of the 21 tests. These values were obtained from a dry bulb thermometer, a sling psychrometer, and a mercury column barometer, respectively. The measurements were made near the forced draft fan inlet.

7. Electrical Currents

   The pulverizer, forced draft fan and ID fan electrical current consumptions were recorded from the Illinois Power continuous monitoring instruments. The data base contains average values for these currents for each of the 21 tests.

8. Steam Flow

   For each test an average steam flow was obtained from the Illinois Power continuous monitoring instruments.

9. Air Heater Leakage

   A constant value of 10% was used as suggested by Illinois Power.

10. Flue Gas Flow Rates

    Table 22 is an inventory of flue gas temperatures, static pressures and velocities for each loaction. The continuous measurements were taken from MITRE strip charts. An average

TABLE 21

AIR HEATER TEMPERATURE INVENTORY

MITRE TEST NUMBER	AIR INPUT C	AIR INPUT D	GAS OUTPUT C	GAS OUTPUT D
11		D		D
9		D		D
8		D		D
12		D		D
7		D		D
1	C	d	C	d
6	C	d	C	d
18	C	d	C	d
13	C	d	C	d
4	C	d	C	d
5	C	d	C	d
10	C	d	C	d
20	C	d	C	d
2	C	d	C	d
3	C	d	C	d
17	C	d	C	d
19	C	d	C	d
21	C	d	C	d
14	C	d	C	d
15	C	d	C	d
22	C	d	C	d

Data used in computation
of efficiency:

C - Continuous (MITRE)
D - Automatic Data Log

Data not used
in computations:

d - Automatic Data Log

TABLE 22

FLUE GAS FLOW RATE INVENTORY

MITRE TEST NUMBER	LOCATION 1									LOCATION 2									LOCATION 3								
	TEMP.			PRESS.			VELOCITY			TEMP.			PRESS.			VELOCITY			TEMP.			PRESS.			VELOCITY		
	C	M	A	C	M	A	C	M	A	C	M	A	C	M	A	C	M	A	C	M	A	C	M	A	C	M	A
11	C			C					A		M			M			M			M			M			M	
9	C			C					A		M			M			M			M			M			M	
8	C			C					A		M			M			M			M			M			M	
12	C			C					A		M			M			M			M			M			M	
7	C			C					A		M			M			M			M			M			M	
1	C			C					A		M			M			M			M			M			M	
6	C			C					A		M			M			M			M			M			M	
18	C			C					A		M			M			M			M			M			M	
13	C			C					A		M			M			M			M			M			M	
4	C			C					A		M			M			M			M			M			M	
5	C			C					A		M			M			M			M			M			M	
10	C			C					A		M			M			M			M			M			M	
20	C			C					A		M			M			M			M			M			M	
2	C			C					A		M			M			M			M			M			M	
3	C			C					A		M			M			M			M			M			M	
17	C			C					A		M			M			M			M			M			M	
19	C			C					A		M			M			M			M			M			M	
21	C			C					A		M			M			M			M			M			M	
14	C			C					A		M			M			M			M			M			M	
15	C			C					A		M			M			M			M			M			M	
22	C			C					A		M			M			M			M			M			M	

DATA USED IN COMPUTATION
OF GAS FLOWS

C - CONTINUOUS (MITRE)
M - MANUAL
A - ARTIFICIAL (COMPUTED FROM ANOTHER LOCATION)

test value was used. The manual measurements were taken once per day by Midwest Research Institute and represent an average value across the duct. It should be noted that the Location 1 velocities were calculated from the manual Location 2 velocities according to the following equation.

$$Vol_1 + L_{1,2} = Vol_2$$

$$A_1V_1\left(\frac{P_1}{T_1}\,\frac{460}{29.92}\right) + F_{1,2}A_1V_1\left(\frac{P_1}{T_1}\,\frac{460}{29.92}\right) = A_2V_2\left(\frac{P_2}{T_2}\,\frac{460}{29.92}\right)$$

$$V_1 = \left(\frac{A_2}{A_1}\right)\left(\frac{P_2}{P_1}\right)\left(\frac{T_1}{T_2}\right)\frac{V_2}{1+F_{1,2}}$$

$$= \left(\frac{347.5}{511.3}\right)\left(\frac{P_2}{P_1}\right)\left(\frac{T_1}{T_2}\right)\frac{V_2}{1+.100}$$

$$V_1 = .61785\left(\frac{P_2}{P_1}\right)\left(\frac{T_1}{T_2}\right)V_2$$

where

Vol_i - location i volume flow

$L_{i,j}$ - leakage from location i to location j

A_i - location i area

V_i - location i velocity

P_i - location i pressure

T_i - location i temperature

$F_{i,j}$ - leakage fraction from location i to j

9. Duct Area

The data base contains average areas for the flue gas ducts at locations 1, 2, and 3.

SECTION V

ANALYSIS OF DATA

This section describes the computational procedures utilized in the analysis of test results. Tabular displays of test results are presented for net and gross efficiency varying load level and excess air; gas mass flow and gas volume flow varying load level and excess air; and gas mass flow and gas volume flow varying load level and fuel type (excess air fixed). Results are also presented for an overall sulfur balance, for grain loading varying load level and soot blowing (fixed fuel type), comparison of continuous measurement results with manual measurements and with theoretical values, and for grain loading varying load level and fuel type.

NET AND GROSS EFFICIENCY AS A VARYING LOAD LEVEL AND EXCESS AIR

Computational Procedures

Net and gross efficiencies were computed for all of the 21 tests in the Baseline Measurement Program.

The efficiency calculations performed were basically those of the ASME publication PTC 4.1 using the heat loss method. Adjustments have been made, where required, based on the Illinois Power Company's computer performance calculations.

The efficiency factor (η) is given by the following equations:

$$\eta_g = 1 - \frac{L}{H_{fuel} + B_{e1}} - .015 - R$$

$$\eta_n = 1 - \frac{L}{H_{fuel} + B_{e1} + B_{e2}} - .015 - R$$

η_g = gross efficiency factor
η_n = net efficiency factor
L = heat losses (BTU/lb, as-fired fuel)
H_{fuel} = heating value (BTU/lb, as-fired fuel)

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B_{e1} = electrical power consumed within system envelope (BTU/lb, as-fired fuel)

B_{e2} = electrical power consumed outside system envelope (BTU/lb, as-fired fuel)

R = radiation loss

The heat losses come from a variety of sources. The major ones are indicated in the following equation.

$$L = L_{UC} + L_{CO} + L_d + L_G + L_{UHC} + L_{mA} + L_{mf} + L_H$$

L_{UC} = heat loss due to unburned carbon in refuse

L_{CO} = heat loss due to formation of carbon monoxide

L_d = heat loss due to sensible heat in flue dust

L_G = heat loss due to heat in dry flue gas

L_{UHC} = heat loss due to unburned hydrocarbons

L_{mA} = heat loss due to moisture in the air

L_{mf} = heat loss due to moisture in the fuel

L_H = heat loss due to moisture from burning of hydrogen

The major sources of electrical power consumption are indicated by the following equations.

$$B_{e1} = (B_{P1} + B_{P2} + B_{P3} + B_{P4})\ (1-R)$$

$$B_{e2} = B_{F1} + B_{F2} + B_{I1} + B_{I2} + B_S + B_w$$

B_{P1} = electric power consumption of pulverizer No. 1

B_{P2} = electric power consumption of pulverizer No. 2

B_{P3} = electric power consumption of pulverizer No. 3

B_{P4} = electric power consumption of pulverizer No. 4

B_{F1} = electric power consumption of F.D. fan 1

B_{F2} = electric power consumption of F.D. fan 2

B_{I1} = electric power consumption of I.D. fan 1

B_{I2} = electric power consumption of I.D. fan 2
B_S = electric power consumption of ash sluice pump
B_w = electric power consumption of service water pump
R = pyrite rejection fraction

Heat Losses -

$$L_{UC} = \frac{W_d}{W_f} H_{fly} + \frac{Ash_f}{1-C_f} H_{pit}$$

$$L_{CO} = \frac{CO_g}{CO_g + CO_{2g}} \times 10160\ C_b$$

$$C_b = C_f - \frac{L_{UC}}{14500}$$

$$L_d = 0.2 \times (t_g - t_{fA}) \frac{W_d}{W_f}$$

$$t_G = t_g + F_L (t_g - t_a)$$

$$L_G = 0.24 \times W_G (t_G - t_a)$$

$$W_G = \frac{44CO_{2g} + 32Q_{2g} + 28(N_{2g} + CO_g)}{12(CO_{2g} + CO_g)} \left[C_b + S_f/2.67\right]$$

$$L_{UHC} = \frac{UHC_g\ W_G\ K_{UHC}}{W_g}$$

$$W_g = \frac{CO_{2g}}{8.76} + \frac{O_{2g}}{12.04} + \frac{CO_g + N_{2g}}{13.75} + \frac{SO_{2g}}{6.01} + \frac{UHC_g}{385.29\ M_{HC}}$$

$$L_{mA} = W_{mA} W_A (h_V - h_{RV})$$

$$W_A = \frac{\frac{2.33 N_{2g}}{CO_g + CO_{2g}} \left[C_b + \frac{S_f}{2.67} \right] - N_f}{0.7685}$$

$$L_{mf} = M_f (1048 - t_{fA} + .48 t_G)$$

$$L_H = 8.936 H_f (1048 - t_{fA} + .48 t_G)$$

W_d = flue gas particulate mass flow rate (lb/hr)
W_f = coal consumption rate (lb/hr)
H_{fly} = heating value for fly ash (BTU/lb)
H_{pit} = heating value for pit ash (BTU/lb)
Ash_f = lb ash per lb fuel
C_f = lb carbon per lb fuel
S_f = lb sulfur per lb fuel
H_f = lb hydrogen per lb fuel
M_f = lb water per lb fuel
N_f = lb nitrogen per lb fuel
C_b = lb carbon burned per lb fuel
CO_{2g} = ft^3 carbon monoxide per ft^3 dry flue gas
O_{2g} = ft^3 oxygen per ft^3 dry flue gas
CO_g = ft^3 carbon monoxide per ft^3 dry flue gas
SO_{2g} = ft^3 sulfur dioxide per ft^3 dry flue gas
UHC_g = ft^3 unburned hydrocarbons per ft^3 dry flue gas
K_{UHC} = BTU/ft^3 of hydrocarbons
N_{2g} = ft^3 nitrogen per ft^3 dry flue gas (by difference)
M_{HC} = molecular weight of hydrocarbons
t_G = corrected air heater exit gas temperature (°F)
t_g = air heater exit gas temperature (°F)
t_{fA} = fuel, air mixture temperature (°F)
t_a = air heater entering air temperature (°F)

W_G = lb dry flue gas per lb fuel
W_g = flue gas specific weight
W_{mA} = lb water vapor per lb dry air
W_A = lb dry air supplied per lb fuel
F_L = lb air leakage per lb air to heater
h_V = enthalpy of vapor at t_G
h_{PV} = enthalpy of vapor at partial pressure corresponding to ambient temperature and relative humidity

Electrical Power Consumption -

$$B = \frac{5.911 \times \text{Volt} \times \text{Amp} \times \text{PF}}{W_f}$$

Volt = voltage (volts)
Amp = current (amperes)
PF = power factor fraction
W_f = coal consumption rate (lb/hr)

Dual Fuel Operation - When natural gas is burned along with coal, corrections must be applied to fuel composition values to convert natural gas to an equivalent amount of coal.

$$V_c = \frac{W_c}{W_c + W_g}$$

$$C_f = V_c (C_c - C_g) + C_g$$

$$S_f = V_c (S_c - S_g) + S_g$$

$H_f = V_c(H_c - H_g) + H_g$
$N_f = V_c(N_c - N_g) + N_g$
$M_f = V_c M_c$
$H_{fuel} = V_c(H_{coal} - H_{gas}) + H_{gas}$

f = subscript for adjusted fuel values

c = coal

g = natural gas

W_c = coal consumption rate (lb/hr)

W_g = gas consumption rate (lb/hr)

C, S, H, N, M = coal composition as defined previously

H_{fuel} = adjusted fuel heating value (BTU/lb)

H_{coal} = coal heating value (BTU/lb)

H_{gas} = natural gas heating value (BTU/lb)

Analysis and Interpretation of Results

As noted from Table 23 the average net efficiency for the tests performed at the 100 MW load level and with A type fuel (Tests 11, 9, 8, 12, and 7) is 88.5%. The average gross efficiency for these same tests is 88.4%.

The average net efficiency for the tests performed at the 75 MW load level and with A type fuel (Tests 4, 2, and 3) is 90.9%. The average gross efficiency for these same tests is 90.8%.

The average net efficiency for the tests performed at the 50 MW load level and with A type fuel (Tests 17, 19, 14, and 15) is 89.5%. The average gross efficiency for these same tests is 89.4%.

As expected from the computational procedures, gross efficiencies are always equal to or less than net efficiences for the same test.

The averaged net and gross efficiencies for the three load levels do show higher values at the 75MW load level when compared to the average values at the 100 MW and 50 MW load level. However, these differences are not of a magnitude to be significant.

A comparison of the average net and gross efficiencies for 100 MW A fuel tests with the 100 MW B fuel test and the 100 MW C fuel test shows no significant differences.

Similarly, no significant differences are shown between 75 MW A, B, and C fuel tests and 50 MW A, B, and C fuel tests.

TABLE 23

NET AND GROSS EFFICIENCY

DATE	MITRE TEST NUMBER	TEST CONDITIONS					NET EFFICIENCY (%)	GROSS EFFICIENCY (%)
		LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE		
11/8/71	11	100	A	NO	NORM.	NORM.	87.8	87.7
11/9/71	9	100	A	NO	MIN.	NORM.	88.6	88.6
11/10/71	8	100	A	NO	MAX.	NORM.	88.2	88.1
11/11/71	12	100	A	YES*	NORM.	NORM.	88.8	88.8
11/12/71	7	100	A	YES	NORM.	NORM.	88.9	88.9
11/15/71	1	75	B	NO	NORM.	NORM.	90.0	89.9
11/16/71	6	100	B	NO	NORM.	NORM.	89.9	89.8
11/17/71	18	50	B	YES	NORM.	NORM.	90.7	90.6
11/18/71	13	35	B	NO	NORM.	NORM.	90.8	90.7
11/19/71	4	75	A	NO	MIN.	NORM.	90.9	90.9
11/22/71	5	75	C	NO	NORM.	NORM.	88.8	88.7
11/23/71	10	100	C	YES	NORM.	NORM.	88.9	88.8
11/24/71	20	50	C	NO	NORM.	NORM.	88.5	88.4
11/30/71	2	75	A	NO	NORM.	NORM.	90.8	90.7
12/1/71	3	75	A	NO	MAX.	NORM.	91.0	90.7
12/2/71	17	50	A	YES	NORM.	NORM.	90.9	90.8
12/3/71	19	50	A	NO	MAX.	NORM.	89.0	88.9
12/4/71	21	35	A	NO	NORM.	NORM.	88.6	88.4
12/7/71	14	50	A	NO	NORM.	MIN.	88.1	88.0
12/8/71	15	50	A	NO	MIN.	NORM.	89.9	89.8
12/9/71	22	75	D	NO	NORM.	NORM.	90.7	90.7

* REDUCED LEVEL OF SOOT BLOWING

GAS MASS FLOW AND GAS VOLUME FLOW VARYING LOAD LEVEL, EXCESS AIR, AND FUEL TYPE

Computational Procedures

Gas mass flows and gas volume flows were computed for Location 1 (economizer) for SO_2, CO_2, O_2, N_2, and total gases. Mass flows and volume flows were also computed at Location 3 (midway in stack) for NO, CO_2, O_2, N_2, and for total gases.

The flow rates for these gases at the two locations were based upon manual velocity measurements as determined by the Midwest Research Institute stack sampling team. These velocity measurements were, in turn, computed by MRI using the following.

$$U_S = 174\ F_{PT} \sqrt{\frac{28.84}{MW_S} \times \frac{29.92}{P_{static}}} \sqrt{T_S\ \Delta P}$$

$$MW_S = 44CO_2 + 32O_2 + 28N_2 + 18H_2O$$

$$P_{static} = P_A - P_{stack}/13.6$$

U_S = velocity (ft/min)

F_{PT} = pitot correction factor (.9)

MW_S = molecular weight of stack gas

P_{static} = static duct pressure (in. H_g)

T_S = stack temperature (°R = °F + 460)

ΔP = stack (pitot) pressure (in. H_g)

CO_2, O_2, N_2 = flue gas constituents (fraction by volume moisture free)

N_2 = $1 - CO_2 - O_2 - H_2O$

H_2O = flue gas moisture fraction

P_A = atmospheric pressure (in. H_g)

P_{stack} = stack pressure (in. H_2O)

As described in Section IV, manual velocity measurements at Location 2 (air heater) were adjusted with respect to pressure, temperature, duct area, and duct leakage to provide estimates of velocities at Loaction 1 (economizer). This procedure was necessary because the velocity measuring instrumentation at Location 1 did not function properly for the major portion of the test program.

Volume flow rates were then calculated at the two locations for each constituent using the measured velocities by means of the following formula.

$$V_m = AV \times Vol_{gas}$$

V_m volume flow (ft^3/min)
A duct area (ft^2)
V velocity (ft/Min)
Vol_{gas} = fraction by volume of gas constituent (as measured by instrumentation system)

Mas flow rates were also calculated for the various gaseous constituents for the total gases using the formula:

$$R_m = \frac{\left[V_m\right] \times \left[MW_{gas}/\left(359\ ft^3/lb\ mole\right)\right]}{\left[\left(T_G + 460\right)/P_{static}\right]\ \left[29.92/\left(460 + 32\right)\right]}$$

$$R_m = .0458\ \frac{\left[\left(V_m\right)\left(MW_{gas}\right)\right]}{\left[\left(T_G + 460\right)/P_{static}\right]}$$

R_m = mass flow (lb/min)
MW_{gas} = molecular weight of gas constituent

TABLE 24

FLOW RATES FOR SO_2 AT LOCATION 1

DATE	MITRE TEST NUMBER	TEST CONDITIONS					VOLUME FLOW (ACTUAL FT^3 PER MIN.)	VOLUME FLOW (STANDARD FT^3 PER MIN.)	MASS FLOW (LB. PER MIN.)
		LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE			
11/8/71	11	100	A	NO	NORM.	NORM.			
11/9/71	9	100	A	NO	MIN.	NORM.			
11/10/71	8	100	A	NO	MAX.	NORM.	1615.9	680.2	121.4
11/11/71	12	100	A	YES*	NORM.	NORM.	1474.7	619.9	110.6
11/12/71	7	100	A	YES	NORM.	NORM.	1615.5	673.8	120.2
11/15/71	1	75	B	NO	NORM.	NORM.	1118.8	471.2	84.1
11/16/71	6	100	B	NO	NORM.	NORM.	1615.4	630.3	112.5
11/17/71	18	50	B	YES	NORM.	NORM.	679.6	282.4	50.4
11/18/71	13	35	B	NO	NORM.	NORM.	491.8	212.3	37.9
11/19/71	4	75	A	NO	MIN.	NORM.	1144.3	474.3	84.6
11/22/71	5	75	C	NO	NORM.	NORM.	196.3	81.8	14.6
11/23/71	10	100	C	YES	NORM.	NORM.	257.0	104.9	18.7
11/24/71	20	50	C	NO	NORM.	NORM.	173.9	75.1	13.4
11/30/71	2	75	A	NO	NORM.	NORM.	990.3	416.6	74.3
12/1/71	3	75	A	NO	MAX.	NORM.	1276.6	534.8	95.4
12/2/71	17	50	A	YES	NORM.	NORM.	673.7	305.9	54.6
12/3/71	19	50	A	NO	MAX.	NORM.	785.9	335.2	59.8
12/4/71	21	35	A	NO	NORM.	NORM.			
12/7/71	14	50	A	NO	NORM.	MIN.	589.3	246.7	44.0
12/8/71	15	50	A	NO	MIN.	NORM.	738.1	313.1	55.9
12/9/71	22	75	D	NO	NORM.	NORM.	404.4	160.7	28.7

* REDUCED LEVEL OF SOOT BLOWING

TABLE 25

FLOW RATES FOR CO_2 AT LOCATION 1

DATE	MITRE TEST NUMBER	TEST CONDITIONS					VOLUME FLOW (ACTUAL FT^3 PER MIN.)	VOLUME FLOW (STANDARD FT^3 PER MIN.)	MASS FLOW (LB. PER MIN.)
		LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE			
11/8/71	11	100	A	NO	NORM.	NORM.			
11/9/71	9	100	A	NO	MIN.	NORM.			
11/10/71	8	100	A	NO	MAX.	NORM.	52,496	22,097	2,709
11/11/71	12	100	A	YES*	NORM.	NORM.			
11/12/71	7	100	A	YES	NORM.	NORM.	49,606	20,690	2,536
11/15/71	1	75	B	NO	NORM.	NORM.	32,095	13,519	1,657
11/16/71	6	100	B	NO	NORM.	NORM.	61,879	24,142	2,959
11/17/71	18	50	B	YES	NORM.	NORM.	41,805	17,374	2,130
11/18/71	13	35	B	NO	NORM.	NORM.	29,212	12,610	1,546
11/19/71	4	75	A	NO	MIN.	NORM.	44,388	18,397	2,255
11/20/71	5	75	C	NO	NORM.	NORM.	31,738	13,226	1,621
11/23/71	10	100	C	YES	NORM.	NORM.	50,692	20,695	2,537
11/24/71	20	50	C	NO	NORM.	NORM.	32,441	14,004	1,717
11/30/71	2	75	A	NO	NORM.	NORM.	58,996	24,821	3,042
12/1/71	3	75	A	NO	MAX.	NORM.	50,973	21,354	2,617
12/2/71	17	50	A	YES	NORM.	NORM.	34,738	15,771	1,933
12/3/71	19	50	A	NO	MAX.	NORM.	32,097	13,689	1,678
12/4/71	21	35	A	NO	NORM.	NORM.			
12/7/71	14	50	A	NO	NORM.	MIN.			
12/8/71	15	50	A	NO	MIN.	NORM.			
12/9/71	22	75	D	NO	NORM.	NORM.			

* REDUCED LEVEL OF SOOT BLOWING

TABLE 26

FLOW RATES FOR O_2 AT LOCATION 1

DATE	MITRE TEST NUMBER	TEST CONDITIONS					VOLUME FLOW (ACTUAL FT^3 PER MIN.)	VOLUME FLOW (STANDARD FT^3 PER MIN.)	MASS FLOW (LB. PER MIN.)
		LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE			
11/8/71	11	100	A	NO	NORM.	NORM.			
11/9/71	9	100	A	NO	MIN.	NORM.			
11/10/71	8	100	A	NO	MAX.	NORM.	36,456	15,345	1,368
11/11/71	12	100	A	YES*	NORM.	NORM.	23,993	10,086	899
11/12/71	7	100	A	YES	NORM.	NORM.	23,683	9,878	880
11/15/71	1	75	B	NO	NORM.	NORM.	24,176	10,183	908
11/16/71	6	100	B	NO	NORM.	NORM.	34,897	13,615	1,213
11/17/71	18	50	B	YES	NORM.	NORM.	19,240	7,996	713
11/18/71	13	35	B	NO	NORM.	NORM.	19,274	8,320	742
11/19/71	4	75	A	NO	MIN.	NORM.	14,817	6,141	547
11/22/71	5	75	C	NO	NORM.	NORM.	12,806	5,337	476
11/23/71	10	100	C	YES	NORM.	NORM.	13,537	5,526	493
11/24/71	20	50	C	NO	NORM.	NORM.	11,375	4,911	438
11/30/71	2	75	A	NO	NORM.	NORM.	20,304	8,542	761
12/1/71	3	75	A	NO	MAX.	NORM.	33,311	13,955	1,244
12/2/71	17	50	A	YES	NORM.	NORM.	12,118	5,501	490
12/3/71	19	50	A	NO	MAX.	NORM.	24,573	10,480	934
12/4/71	21	35	A	NO	NORM.	NORM.			
12/7/71	14	50	A	NO	NORM.	MIN.	12,632	5,288	471
12/8/71	15	50	A	NO	MIN.	NORM.	13,178	5,589	498
12/9/71	22	75	D	NO	NORM.	NORM.	23,107	9,181	818

* REDUCED LEVEL OF SOOT BLOWING

TABLE 27

FLOW RATES FOR N_2 AT LOCATION 1

(NO FRACTION COUNTED AS N_2)

DATE	MITRE TEST NUMBER	TEST CONDITIONS					VOLUME FLOW (ACTUAL FT^3 PER MIN.)	VOLUME FLOW (STANDARD FT^3 PER MIN.)	MASS FLOW (LB. PER MIN.)
		LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE			
11/8/71	11	100	A	NO	NORM.	NORM.			
11/9/71	9	100	A	NO	MIN.	NORM.			
11/10/71	8	100	A	NO	MAX.	NORM.	638,546	268,778	20,968
11/11/71	12	100	A	YES*	NORM.	NORM.			
11/12/71	7	100	A	YES	NORM.	NORM.	600,010	250,261	19,524
11/15/71	1	75	B	NO	NORM.	NORM.	482,031	203,034	15,839
11/16/71	6	100	B	NO	NORM.	NORM.	710,484	277,195	21,625
11/17/71	18	50	B	YES	NORM.	NORM.	334,532	139,029	10,846
11/18/71	13	35	B	NO	NORM.	NORM.	252,178	108,861	8,493
11/19/71	4	75	A	NO	MIN.	NORM.	435,611	180,539	14,084
11/22/71	5	75	C	NO	NORM.	NORM.	512,065	213,394	16,648
11/23/71	10	100	C	YES	NORM.	NORM.	598,158	244,201	19,051
11/24/71	20	50	C	NO	NORM.	NORM.	324,657	140,152	10,934
11/30/71	2	75	A	NO	NORM.	NORM.	430,498	181,120	14,130
12/1/71	3	75	A	NO	MAX.	NORM.	510,615	213,906	16,688
12/2/71	17	50	A	YES	NORM.	NORM.	275,612	125,127	9,762
12/3/71	19	50	A	NO	MAX.	NORM.	356,697	152,125	11,868
12/4/71	21	35	A	NO	NORM.	NORM.			
12/7/71	14	50	A	NO	NORM.	MIN.			
12/8/71	15	50	A	NO	MIN.	NORM.			
12/9/71	22	75	D	NO	NORM.	NORM.			

* REDUCED LEVEL OF SOOT BLOWING

TABLE 28

FLOW RATES FOR ALL GASES AT LOCATION 1
(SO_2, CO_2, O_2, N_2 WITH
NO FRACTION COUNTED AS N_2)

DATE	MITRE TEST NUMBER	TEST CONDITIONS					VOLUME FLOW (ACTUAL FT^3 PER MIN.)	VOLUME FLOW (STANDARD FT^3 PER MIN.)	MASS FLOW (LB. PER MIN.)
		LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE			
11/8/71	11	100	A	NO	NORM.	NORM.			
11/9/71	9	100	A	NO	MIN.	NORM.			
11/10/71	8	100	A	NO	MAX.	NORM.	729,113	306,900	25,166
11/11/71	12	100	A	YES*	NORM.	NORM.	646,283	271,668	21,598
11/12/71	7	100	A	YES	NORM.	NORM.	674,916	281,504	23,061
11/15/71	1	75	B	NO	NORM.	NORM.	539,421	227,207	18,488
11/16/71	6	100	B	NO	NORM.	NORM.	808,876	315,582	25,910
11/17/71	18	50	B	YES	NORM.	NORM.	396,257	164,682	13,739
11/18/71	13	35	B	NO	NORM.	NORM.	301,155	130,003	10,818
11/19/71	4	75	A	NO	MIN.	NORM.	495,961	205,551	16,971
11/22/71	5	75	C	NO	NORM.	NORM.	556,805	232,039	18,759
11/23/71	10	100	C	YES	NORM.	NORM.	662,644	270,528	22,099
11/24/71	20	50	C	NO	NORM.	NORM.	368,647	159,142	13,101
11/30/71	2	75	A	NO	NORM.	NORM.	510,788	214,900	18,008
12/1/71	3	75	A	NO	MAX.	NORM.	596,175	249,749	20,644
12/2/71	17	50	A	YES	NORM.	NORM.	323,141	146,705	12,240
12/3/71	19	50	A	NO	MAX.	NORM.	414,153	176,629	14,540
12/4/71	21	35	A	NO	NORM.	NORM.			
12/7/71	14	50	A	NO	NORM.	MIN.			
12/8/71	15	50	A	NO	MIN.	NORM.			
12/9/71	22	75	D	NO	NORM.	NORM.			

* REDUCED LEVEL OF SOOT BLOWING

TABLE 29

FLOW RATES FOR NO AT LOCATION 3

DATE	MITRE TEST NUMBER	TEST CONDITIONS					VOLUME FLOW (ACTUAL FT^3 PER MIN.)	VOLUME FLOW (STANDARD FT^3 PER MIN.)	MASS FLOW (LB. PER MIN.)
		LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE			
11/8/71	11	100	A	NO	NORM.	NORM.			
11/9/71	9	100	A	NO	MIN.	NORM.			
11/10/71	8	100	A	NO	MAX.	NORM.	221.8	142.3	11.9
11/11/71	12	100	A	YES*	NORM.	NORM.	151.7	97.5	8.1
11/12/71	7	100	A	YES	NORM.	NORM.	149.7	94.7	7.9
11/15/71	1	75	B	NO	NORM.	NORM.	118.5	75.3	6.3
11/16/71	6	100	B	NO	NORM.	NORM.	115.0	73.3	6.1
11/17/71	18	50	B	YES	NORM.	NORM.	74.4	48.8	4.1
11/18/71	13	35	B	NO	NORM.	NORM.	55.7	37.2	3.1
11/19/71	4	75	A	NO	MIN.	NORM.	102.4	66.5	5.6
11/22/71	5	75	C	NO	NORM.	NORM.	56.6	38.0	3.2
11/23/71	10	100	C	YES	NORM.	NORM.	35.5	23.3	1.9
11/24/71	20	50	C	NO	NORM.	NORM.	26.5	18.2	1.5
11/30/71	2	75	A	NO	NORM.	NORM.	88.8	58.2	4.9
12/1/71	3	75	A	NO	MAX.	NORM.	109.5	72.5	6.1
12/2/71	17	50	A	YES	NORM.	NORM.	62.3	42.1	3.5
12/3/71	19	50	A	NO	MAX.	NORM.	84.8	57.0	4.8
12/4/71	21	35	A	NO	NORM.	NORM.	30.9	21.0	1.8
12/7/71	14	50	A	NO	NORM.	MIN.	38.8	25.2	2.1
12/8/71	15	50	A	NO	MIN.	NORM.	47.1	31.3	2.6
12/9/71	22	75	D	NO	NORM.	NORM.	57.9	36.9	3.1

* REDUCED LEVEL OF SOOT BLOWING

TABLE 30

FLOW RATES FOR SO_2 AT LOCATION 3

DATE	MITRE TEST NUMBER	TEST CONDITIONS					VOLUME FLOW (ACTUAL FT^3 PER MIN.)	VOLUME FLOW (STANDARD FT^3 PER MIN.)	MASS FLOW (LB. PER MIN.)
		LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE			
11/8/71	11	100	A	NO	NORM.	NORM.			
11/9/71	9	100	A	NO	MIN.	NORM.			
11/10/71	8	100	A	NO	MAX.	NORM.	554.9	356.0	63.5
11/11/71	12	100	A	YES*	NORM.	NORM.	679.3	436.0	77.9
11/12/71	7	100	A	YES	NORM.	NORM.	806.8	510.2	91.0
11/15/71	1	75	B	NO	NORM.	NORM.	608.5	386.6	69.0
11/16/71	6	100	B	NO	NORM.	NORM.	765.7	488.1	87.1
11/17/71	18	50	B	YES	NORM.	NORM.	304.7	199.9	35.7
11/18/71	13	35	B	NO	NORM.	NORM.	219.6	146.8	26.2
11/19/71	4	75	A	NO	MIN.	NORM.	606.1	393.6	70.2
11/22/71	5	75	C	NO	NORM.	NORM.	167.1	112.1	20.0
11/23/71	10	100	C	YES	NORM.	NORM.	192.5	126.1	22.5
11/24/71	20	50	C	NO	NORM.	NORM.	102.0	70.1	12.5
11/30/71	2	75	A	NO	NORM.	NORM.	452.1	296.5	52.9
12/1/71	3	75	A	NO	MAX.	NORM.	586.4	388.5	69.3
12/2/71	17	50	A	YES	NORM.	NORM.	361.2	243.9	43.5
12/3/71	19	50	A	NO	MAX.	NORM.	381.1	256.2	45.7
12/4/71	21	35	A	NO	NORM.	NORM.	259.4	176.1	31.4
12/7/71	14	50	A	NO	NORM.	MIN.	341.1	221.6	39.6
12/8/71	15	50	A	NO	MIN.	NORM.			
12/9/71	22	75	D	NO	NORM.	NORM.	589.1	374.9	66.9

* REDUCED LEVEL OF SOOT BLOWING

TABLE 31

FLOW RATES FOR CO_2 AT LOCATION 3

DATE	MITRE TEST NUMBER	TEST CONDITIONS					VOLUME FLOW (ACTUAL FT^3 PER MIN.)	VOLUME FLOW (STANDARD FT^3 PER MIN.)	MASS FLOW (LB. PER MIN.)
		LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE			
11/8/71	11	100	A	NO	NORM.	NORM.			
11/9/71	9	100	A	NO	MIN.	NORM.			
11/10/71	8	100	A	NO	MAX.	NORM.	46,737	29,281	3,675
11/11/71	12	100	A	YES*	NORM.	NORM.	47,415	30,454	3,733
11/12/71	7	100	A	YES	NORM.	NORM.	53,335	33,728	4,134
11/15/71	1	75	B	NO	NORM.	NORM.	45,041	28,611	3,507
11/16/71	6	100	B	NO	NORM.	NORM.	55,686	35,502	4,352
11/17/71	18	50	B	YES	NORM.	NORM.	27,973	18,351	2,249
11/18/71	13	35	B	NO	NORM.	NORM.	20,501	13,705	1,680
11/19/71	4	75	A	NO	MIN.	NORM.	41,380	26,869	3,293
11/22/71	5	75	C	NO	NORM.	NORM.	32,880	22,059	2,704
11/23/71	10	100	C	YES	NORM.	NORM.	47,093	30,837	3,780
11/24/71	20	50	C	NO	NORM.	NORM.	22,775	15,656	1,919
11/30/71	2	75	A	NO	NORM.	NORM.	36,375	23,856	2,924
12/1/71	3	75	A	NO	MAX.	NORM.	41,285	27,350	3,352
12/2/71	17	50	A	YES	NORM.	NORM.	24,589	16,605	2,035
12/3/71	19	50	A	NO	MAX.	NORM.	26,459	17,789	2,180
12/4/71	21	35	A	NO	NORM.	NORM.	19,297	13,102	1,606
12/7/71	14	50	A	NO	NORM.	MIN.	27,002	17,547	2,151
12/8/71	15	50	A	NO	MIN.	NORM.	25,786	17,116	2,098
12/9/71	22	75	D	NO	NORM.	NORM.	39,472	25,120	3,079

* REDUCED LEVEL OF SOOT BLOWING

TABLE 32

FLOW RATES FOR O_2 AT LOCATION 3

DATE	MITRE TEST NUMBER	TEST CONDITIONS					VOLUME FLOW (ACTUAL FT^3 PER MIN.)	VOLUME FLOW (STANDARD FT^3 PER MIN.)	MASS FLOW (LB. PER MIN.)
		LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE			
11/8/71	11	100	A	NO	NORM.	NORM.			
11/9/71	9	100	A	NO	MIN.	NORM.			
11/10/71	8	100	A	NO	MAX.	NORM.	29,742	19,079	1,700
11/11/71	12	100	A	YES*	NORM.	NORM.	30,965	19,888	1,773
11/12/71	7	100	A	YES	NORM.	NORM.	24,720	15,632	1,393
11/15/71	1	75	B	NO	NORM.	NORM.	22,680	14,407	1,284
11/16/71	6	100	B	NO	NORM.	NORM.	27,238	17,365	1,548
11/17/71	18	50	B	YES	NORM.	NORM.	15,408	10,108	901
11/18/71	13	35	B	NO	NORM.	NORM.	13,646	9,122	813
11/19/71	4	75	A	NO	MIN.	NORM.	18,067	11,731	1,046
11/22/71	5	75	C	NO	NORM.	NORM.	8,485	5,693	507
11/23/71	10	100	C	YES	NORM.	NORM.	21,542	14,106	1,257
11/24/71	20	50	C	NO	NORM.	NORM.	12,721	8,744	779
11/30/71	2	75	A	NO	NORM.	NORM.	15,979	10,479	934
12/1/71	3	75	A	NO	MAX.	NORM.	25,256	16,731	1,491
12/2/71	17	50	A	YES	NORM.	NORM.	13,498	9,116	812
12/3/71	19	50	A	NO	MAX.	NORM.	18,059	12,142	1,082
12/4/71	21	35	A	NO	NORM.	NORM.	11,990	8,141	726
12/7/71	14	50	A	NO	NORM.	MIN.	13,501	8,773	782
12/8/71	15	50	A	NO	MIN.	NORM.	12,987	8,620	768
12/9/71	22	75	D	NO	NORM.	NORM.	16,412	10,445	931

* REDUCED LEVEL OF SOOT BLOWING

TABLE 33

FLOW RATES FOR N_2 AT LOCATION 3

DATE	MITRE TEST NUMBER	TEST CONDITIONS					VOLUME FLOW (ACTUAL FT^3 PER MIN.)	VOLUME FLOW (STANDARD FT^3 PER MIN.)	MASS FLOW (LB. PER MIN.)
		LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE			
11/8/71	11	100	A	NO	NORM.	NORM.			
11/9/71	9	100	A	NO	MIN.	NORM.			
11/10/71	8	100	A	NO	MAX.	NORM.	347,624	222,996	17,397
11/11/71	12	100	A	YES*	NORM.	NORM.	307,852	197,725	15,425
11/12/71	7	100	A	YES	NORM.	NORM.	316,059	199,870	15,593
11/15/71	1	75	B	NO	NORM.	NORM.	250,990	159,437	12,438
11/16/71	6	100	B	NO	NORM.	NORM.	319,719	203,830	15,902
11/17/71	18	50	B	YES	NORM.	NORM.	162,228	106,427	8,303
11/18/71	13	35	B	NO	NORM.	NORM.	125,742	84,060	6,558
11/19/71	4	75	A	NO	MIN.	NORM.	231,253	150,157	11,714
11/22/71	5	75	C	NO	NORM.	NORM.	223,571	149,993	11,701
11/23/71	10	100	C	YES	NORM.	NORM.	290,170	190,009	14,823
11/24/71	20	50	C	NO	NORM.	NORM.	144,559	99,370	7,752
11/30/71	2	75	A	NO	NORM.	NORM.	206,926	135,709	10,587
12/1/71	3	75	A	NO	MAX.	NORM.	245,528	162,654	12,689
12/2/71	17	50	A	YES	NORM.	NORM.	143,898	97,177	7,581
12/3/71	19	50	A	NO	MAX.	NORM.	165,008	110,937	8,655
12/4/71	21	35	A	NO	NORM.	NORM.	122,802	83,378	6,505
12/7/71	14	50	A	NO	NORM.	MIN.	150,424	97,752	7,626
12/8/71	15	50	A	NO	MIN.	NORM.	148,038	98,260	7,666
12/9/71	22	75	D	NO	NORM.	NORM.	233,098	148,345	11,573

* REDUCED LEVEL OF SOOT BLOWING

TABLE 34

FLOW RATES FOR ALL GASES AT LOCATION 3
(NO, SO_2, CO_2, O_2, & N_2)

DATE	MITRE TEST NUMBER	TEST CONDITIONS					VOLUME FLOW (ACTUAL FT^3 PER MIN.)	VOLUME FLOW (STANDARD FT^3 PER MIN.)	MASS FLOW (LB. PER MIN.)
		LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE			
11/8/71	11	100	A	NO	NORM.	NORM.			
11/9/71	9	100	A	NO	MIN.	NORM.			
11/10/71	8	100	A	NO	MAX.	NORM.	424,879	272,554	22,848
11/11/71	12	100	A	YES*	NORM.	NORM.	387,063	248,601	21,017
11/12/71	7	100	A	YES	NORM.	NORM.	395,070	249,835	21,219
11/15/71	1	75	B	NO	NORM.	NORM.	319,438	202,917	17,305
11/16/71	6	100	B	NO	NORM.	NORM.	403,524	257,258	21,894
11/17/71	18	50	B	YES	NORM.	NORM.	205,988	135,135	11,493
11/18/71	13	35	B	NO	NORM.	NORM.	160,163	107,071	9,080
11/19/71	4	75	A	NO	MIN.	NORM.	291,409	189,217	16,129
11/22/71	5	75	C	NO	NORM.	NORM.	265,160	177,894	14,936
11/23/71	10	100	C	YES	NORM.	NORM.	359,034	235,102	19,885
11/24/71	20	50	C	NO	NORM.	NORM.	180,184	123,858	10,465
11/30/71	2	75	A	NO	NORM.	NORM.	259,821	170,399	14,503
12/1/71	3	75	A	NO	MAX.	NORM.	312,764	207,196	17,608
12/2/71	17	50	A	YES	NORM.	NORM.	182,408	123,184	10,476
12/3/71	19	50	A	NO	MAX.	NORM.	209,992	141,181	11,968
12/4/71	21	35	A	NO	NORM.	NORM.	154,380	104,818	8,869
12/7/71	14	50	A	NO	NORM.	MIN.	191,306	124,319	10,600
12/8/71	15	50	A	NO	MIN.	NORM.	186,857	124,027	10,534
12/9/71	22	75	D	NO	NORM.	NORM.	289,629	184,322	15,653

* REDUCED LEVEL OF SOOT BLOWING

Gas	MW_{gas}
CO	28.01
CO_2	44.01
O_2	32.00
N_2	28.01
SO_2	64.07
NO_2	46.01
NO	30.01

t_G = gas temperature (°F)

P_{static} = see velocity calculation

The results of these calculations are provided in Table 24 through 34. Where no entries appear on these tables for volume flow and for mass flow, the computations could not be performed because of insufficient data (due to either equipment failure or instrument failure).

Analysis and Interpretation of Results

As noted in Table 24, the SO_2 flow rate at location 1 (stated in terms of mass flow - lbs per minute) appears to be consistent with the sulfur content of the fuel. The average mass flow for three 100 MW A fuel tests (tests 8, 12, and 7) is 117.4 lbs/minute. The average sulfur content of the coal consumed in these three A fuel tests was 3.42% (on "as fired" dry basis). This average is greater than the 112.5 lbs per minute recorded for test 6, a 100 MW B fuel test which consumed fuel with a 2.88% sulfur content. Both sets of tests in turn showed greater SO_2 mass flow than test 10, a 100 MW C fuel test (simulated 1.08% sulfur fuel). In a similar comparison, the average SO_2 flow rate for three 75 MW A fuel tests (tests 4, 2, and 3) is 84.8 lbs/minute. These three tests utilized coal of 3.32% average sulfur content. This average was approximately equal to the 75MW B fuel test (test 1) which utilized coal with an average sulfur content of 3.29% sulfur. Both the A and B fuel tests showed a greater mass flow of SO_2 than the 75 MW C fuel test (test 5) which utilized gas and coal to simulate a 0.86% sulfur coal. The 75MW D fuel test (test 22) produced an SO_2 mass flow that was higher than expected; however, the analysis of the coal consumed in this test showed it to be of 1.4% sulfur content rather than the expected .5% sulfur content. The SO_2 mass flows noted for this test were therefore consistent with this measured sulfur content. Similar relationships were found in the 50 MW tests with A, B, and C fuels. No significant changes in SO_2 mass flow were found which were traceable to changes in the soot blowing cycle or in excess air settings.

Table 25 provides the CO_2 flow rate at location 1 for the various tests. An examination of the mass flow of CO_2 (in lbs per minute) shows that for a fixed fuel type the CO_2 mass flow decreases with decreasing load levels (as would be expected with the reduced coal feed rates associated with the lower loads). Table 25 also illustrates that, for a fixed load level, the CO_2 mass flow rates were not significantly different for fuel types A, B, and C.

Table 26 provides results on the O_2 flow rates at location 1. These results show that the O_2 mass flow rate decreases with decreasing load level, and for a fixed load level is not significantly different for fuel types A and B. Tests performed on C type fuel produced O_2 mass flow rates which were both greater and lower than the corresponding tests with A and B fuel dependent upon the load level. The greatest differences were found between tests with fixed load level and fixed fuel types where excess air was the parameter varied.

Flow rates for N_2 mass flow are shown on Table 27. These results show that the N_2 mass flow rate decreases with decreasing load level, and for fixed load levels are not significantly different for fuel types A, B, and C. For fixed load levels and fixed fuel types, greater N_2 mass flow was found for the maximum excess air test.

The flow rates for all gases shown in Table 28 represent the total of the previous four tables and, as such, show the same relationships as the individual gases (i.e., same decrease with decreasing load level and same increase with increased excess air).

Table 29 provides results on the NO flow rates as measured at location 3. Tests performed on A type fuel produced NO mass flow rates which were both greater and lower than the corresponding tests with B fuel dependent upon the load level. However, for all load levels, the NO flow rates with C fuel (predominantly natural gas) were significantly lower than the tests performed with A and B fuels.

Table 30 provides the SO_2 flow rates measured at location 3. The relationships noted in Table 30 are similar to those noted in Table 24 for location 1, i.e., for a fixed fuel type the SO_2 mass flow is reduced for reduced load levels. Inconsistencies were found in the comparison between the 100 MW A fuel test (tests 8, 12, and 7) and the 100 MW B fuel test (test 6). Although the sulfur content was lower for the B fuel, the SO_2 mass flow measured on test 6 was greater than the average SO_2 mass flow for tests 8, 12, and 7. The results from test 10 did show the lower levels for SO_2 mass flow expected for a 100 MW C fuel test. The average SO_2 mass flow rate for the three 75 MW A fuel tests (tests 4, 2, and 3) is approximately equal to the mass flow for the 75 MW B fuel test (test 1); however, as was previously noted, the sulfur content of the coal consumed in these tests was approximately equal. As was true of the measurements at location 1, the A and B fuel tests performed at the 75 MW load level produced higher SO_2 mass flows than measured in the 75 MW C fuel test. Similar relationships were found in the 50 MW tests with A, B, and C fuels.

The CO_2 flow rates measured at location 3 are provided in Table 31. As shown in Table 31, for fixed fuel types, the CO_2 mass flow decreases with decreasing levels. Table 31 also illustrates that for a fixed load level, the CO_2 mass flow rates were not significantly different for fuel types A, B, and C.

Flow rates for O_2 at location 3 are provided in Table 32. These results show that the O_2 mass flow rate decreases with decreasing load level and for a fixed load level is not significantly different for fuel types A and B. Tests performed with C fuel produced O_2 mass flows which were both greater and lower than the corresponding tests with A and B fuel dependent upon the load level. Differences were found in O_2 mass flow rate between tests at the 50 MW load level with A fuel where excess air was varied (tests 19, 14, and 15). Similar differences were not found for 100 MW A fuel tests where excess air was varied.

Flow rates for N_2 at location 3, as shown in Table 33, illustrate that the N_2 mass flow rates decrease with decreasing load levels, and for fixed load levels are not significantly different for fuel types A, B, and C. For fixed load levels and fixed fuel types, greater N_2 flow was found for the maximum excess air tests.

The flow rates for all gases shown in Table 34 are based upon the totals for all measured gases. The same relationships are therefore shown as for the individual gases (i.e., same decrease in flow rate with decreasing load level and same increase with increased excess air).

SULFUR BALANCE

Computational Procedures

For each of the tests performed in the baseline program, the average coal consumption rate was determined utilizing the manual coal scale readings. The average sulfur content of the coal (as determined by chemical analysis) was then used with the coal scale readings to determine the rate of sulfur feed to the steam generator. Average SO_2 mass flow readings from the continuous instrumentation system at the stack were then used to determine the average sulfur flow at the stack (where lbs sulfur/minute = lbs SO_2/minute x $\frac{\text{molecular weight sulfur}}{\text{molecular weight } SO_2}$ = lbs SO_2/minute x .50). The rate of sulfur feed into the steam generator was then compared with the rate of sulfur flow through the stack.

Analysis and Interpretation of Results

The results of the sulfur balance calculations are summarized in Table 35. These results are based upon measurement of the SO_2 concentration of the stack gas with the exception of test 15 in which SO_2 concentrations measured at location 1 (economizer) were corrected using estimated system leakage values to provide an estimate of SO_2 concentration in the stack. In all cases, the measurements of SO_2 concentrations do not include measurement of the sulfur exhausted from the stack as SO_3 or the sulfur adsorbed on the ash as SO_2 and SO_3. The results provided in Table 35 show good agreement on the sulfur balance leading to the conclusion that the total combined error in SO_2 and gas flow measurements

TABLE 35

SULFUR BALANCE

DATE	MITRE TEST NO.	LOAD (MW)	FUEL	SOOT BLOWER	EXCESS AIR	BURNER ANGLE	AVERAGE COAL FLOW(1) (10^3 LB/HR)	% SULFUR IN COAL(2)	AVERAGE SULFUR FEED (LB/HR)	AVERAGE SULFUR FEED (LB/MIN)	AVERAGE SO_2 FLOW(3) (LB/MIN)	AVERAGE SULFUR FLOW (LB/MIN)	SULFUR FEED-FLOW (LB/MIN)
11/8/71	11	100	A	NO	NORM	NORM	85.0	3.37	2865	47.7			
11/9/71	9	100	A	NO	MIN	NORM	83.5	3.40	2839	47.3			
11/10/71	8	100	A	NO	MAX	NORM	63.7	3.37	2147	35.8	63.5	31.8	4.0
11/11/71	12	100	A	YES*	NORM	NORM	83.9	3.24	2718	45.3	77.9	39.0	6.3
11/12/71	7	100	A	YES	NORM	NORM	84.2	3.28	2762	46.0	91.0	45.5	0.5
11/15/71	1	75	B	NO	NORM	NORM	64.8	3.16	2048	34.1	69.0	34.5	-0.4
11/16/71	6	100	B	NO	NORM	NORM	90.1	2.76	2514	41.9	87.1	43.6	-1.7
11/17/71	18	50	B	YES	NORM	NORM	48.3	2.57	1241	20.7	35.7	17.9	2.8
11/18/71	13	35	B	NO	NORM	NORM	32.3	2.51	811	13.5	26.2	13.1	0.4
11/19/71	4	75	A	NO	MIN	NORM	63.2	3.37	2130	35.5	70.2	35.1	0.4
11/22/71	5	75	C	NO	NORM	NORM	34.0	1.83	622	10.4	20.0	10.0	0.4
11/23/71	10	100	C	YES	NORM	NORM	46.4	1.65	766	12.8	22.5	11.3	1.5
11/24/71	20	50	C	NO	NORM	NORM	26.0	1.68	437	7.3	12.5	6.3	1.0
11/30/71	2	75	A	NO	NORM	NORM	66.2	2.87	1900	31.7	52.9	26.5	5.2
12/1/71	3	75	A	NO	MAX	NORM	65.2	3.31	2158	36.0	69.3	34.7	1.3
12/2/71	17	50	A	YES	NORM	NORM	45.4	3.46	1571	26.2	43.5	21.8	4.4
12/3/71	19	50	A	NO	MAX	NORM	50.5	3.47	1752	29.2	45.7	22.9	6.3
12/4/71	21	35	A	NO	NORM	NORM	32.4	3.09	1001	16.7	31.4	15.7	1.0
12/7/71	14	50	A	NO	NORM	MIN	47.0	2.74	1288	21.5	39.6	19.8	1.7
12/8/71	15	50	A	NO	MIN	NORM	46.3	3.37	1560	26.0	46.6**	23.3**	2.7
12/9/71	22	75	D	NO	NORM	NORM	63.2	1.33	841	14.0	24.2	12.1	1.9

* Reduced level of soot blowing
** Location 1

(1) Coal Scale Measurement
(2) Midwest & IGS Average
(3) MITRE Measurement at Location 3

was low. As noted in Table 35, in all cases except two cases (tests 1 and 6), the sulfur feed rate exceeded the sulfur flow rate measured in the stack indicating that there were, in fact, small unmeasured losses of sulfur.

GRAIN LOADING VARYING LOAD LEVEL, FUEL TYPE, AND SOOT BLOWING

Computational Procedures

Grain loadings were determined at location 2 and location 3 for all tests by means of manual measurements. These manual measurements were taken by the Midwest Research Institute using the sampling train and the operating techniques specified in the Federal Register of December 23, 1971 (Volume 36, Number 247).

As noted previously, the results of the preliminary measurement program indicated that the best method for measuring grain loading at location 2 was a 20-point, two-probe traverse in one-half of each of the two ducts (a total of 40 points). The halves selected were varied from test to test to provide representative sampling of the total duct.

A location 3, the grain loading for the total stack was determined by a 32-point traverse to obtain representative samples.

A summary of the grain loading results is provided in Table 36. The emission rates shown in Table 36 were computed using the measured grain loadings and the manually determined gas mass flow with the appropriate conversion factors to provide values in terms of pounds of particulates per hour.

The mechanical collection efficiencies shown in Table 36 were calculated using the emission rates for the two locations (location 2 prior to collection and location 3 after collection). Because of the configuration of the ducting, this collection efficiency reflects an ash removal capability that is a result, not only of the effects of the mechanical collector proper but, also, of the lower tubes of the air heater, and the ducting between the air heater and the stack. For this reason, the efficiencies shown are not absolute values but are to be considered as relative measurements to be used only in test-to-test comparisons.

TABLE 9

GRAIN LOADING MEASUREMENTS

DATE	MITRE TEST NO. (OLD)	LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	AIR BURNER ANGLE	GRAIN LOADING				EMISSION RATE LB/HR.		MECHANICAL COLLECTOR EFFICIENCY (%)	ASH CONTENT OF COAL AS RECEIVED BASIS
							GRAINS/SCF		GRAINS/ACF					
							LOCATION 2	LOCATION 3	LOCATION 2	LOCATION 3	LOCATION 2	LOCATION 3		
11/8/71	11	100	A	NO	NORM.	NORM.	4.15	0.95	2.42	0.61	9178	--	--	10.03
11/9/71	9	100	A	NO	MIN.	NORM.	4.58	0.88	2.64	0.58	8460	--	--	9.89
11/10/71	8	100	A	NO	MAX.	NORM.	4.41	0.94	2.55	0.60	9796	2166	77.9	10.25
11/11/71	12	100	A	YES*	NORM.	NORM.	4.25	1.16	2.44	0.75	8252	2474	70.0	10.75
11/12/71	7	100	A	YES	NORM.	NORM.	5.09 5.38	1.44 1.50	2.94 2.96	0.91 0.93	10596	3104	70.5	10.07
11/16/71	6	100	B	NO	NORM.	NORM.	4.48	1.34	2.49	0.85	9808	2930	70.0	11.30
11/15/71	1	75	B	NO	NORM.	NORM.	5.58	1.08	3.14	0.68	8990	1856	79.5	10.42
11/17/71	18	50	B	YES	NORM.	NORM.	7.80 9.70	1.50 1.42	4.57 5.67	0.98 0.93	9830	1672	83.0	12.15
11/18/71	13	35	B	NO	NORM.	NORM.	3.79	1.00	2.30	0.68	3408	926	72.9	13.13
11/19/71	4	75	A	NO	MIN.	NORM.	4.27	0.66	2.45	0.43	6176	1072	82.7	10.35
11/22/71	5	75	C	NO	NORM.	NORM.	3.23	0.89	1.89	0.39	4978	1335	73.2	13.57
11/23/71	10	100	C	YES	NORM.	NORM.	5.71 6.12	1.24 1.38	3.23 3.49	0.78 0.90	11160	2573	76.9	16.69
11/24/71	20	50	C	NO	NORM.	NORM.	3.63	1.12	2.20	0.76	3676	1164	68.5	15.94
11/30/71	2	75	A	NO	NORM.	NORM.	6.03	0.87	3.52	0.57	9096	1268	86.0	9.85
12/1/71	3	75	A	NO	MAX.	NORM.	4.18	0.68	2.47	0.45	7256	1215	83.3	10.00
12/2/71	17	50	A	YES	NORM.	NORM.	6.35 7.05	1.15 0.85	3.85 4.28	0.79 0.60	7080	1067	84.9	10.14
12/3/71	19	50	A	NO	MAX.	NORM.	3.72	0.54	2.27	0.37	4482	659	85.3	9.56
12/4/71	21	35	A	NO	NORM.	NORM.	2.69	1.12	1.62	0.77	2412	1023	57.5	9.14
12/7/71	14	50	A	NO	NORM.	MIN.	4.82	1.16	2.76	0.76	4862	1248	74.4	10.78
12/8/71	15	50	A	NO	MIN.	NORM.	4.10	0.90	2.40	0.60	4222	956	77.5	10.44
12/9/71	22	75	D	NO	NORM.	NORM.	2.80	0.75	1.62	0.48	4286	1200	72.0	6.61

*Reduced level of soot blowing

The ash content of the coal is determined by laboratory analysis is also provided in Table 36 as a factor affecting the measured grain loading.

Analysis and Interpretation of Results

As noted in Table 36, tests were performed with type A fuel at two load levels (100 MW and 50 MW) in which operating conditions were held constant except for soot blowing.

In the first of these comparisons, test 7, an average value of 5.23 grains/SCF was measured at location 2. This represents an increase over the average grain loading measured in tests 11, 9, and 8 (4.38 grains/SCF). For these three tests, no soot blowing was used during the period of the test. The average ash content of the coal for tests 11, 9, and 8 was approximately equal to that measured for test 7, indicating that the differences in grain loading were not attributable to this source.

For these same tests, the grain loading measurements at location 3 were also higher for the test in which soot blowing was conducted.

At the 50 MW level, the average grain loading measured at location 2 was 6.70 grains/SCF for test 17. In this test, soot blowing was used during the test. This result is higher than any of the grain loading measurements obtained for the 50 MW A fuel tests in which soot blowing was not conducted (tests 19, 14, and 15). As was the case with the 100 MW comparisons, these 50 MW tests utilized coal of approximately the same ash content.

Two tests were run in which soot blowing was used and all other operating parameters were constant except for fuel type. In the first of these tests (test 18), B fuel was utilized. This fuel has a higher ash content than the A fuel, and for this B fuel test an average grain loading of 8.75 grains/SCF was recorded at location 2. This represents an increase over the results recorded for test 17, in which A fuel was utilized. For the A fuel test, an average grain loading of 6.70 grains/SCF was measured. These two tests indicate the degree of change in grain loading that is attributable to differences in ash content of the coal.

No specific patterns were found in the analysis of results in terms of the mechanical collection efficiencies. However, in general it was noted that greater efficiencies were noted for the tests in which B fuel was utilized.

COMPARISON OF CONTINUOUS MEASUREMENT RESULTS WITH MANUAL MEASUREMENTS AND WITH THEORETICAL VALUES

Computational Procedures

As described in a previous section, the scope of the Baseline Measurement Test included manual measurements as well as measurements obtained by the continuous measurement systems. The manual gas measurements for NO_x, CO, CO_2, and SO_2 were determined by laboratory analysis of a grab sample. Measurements of O_2 and CO_2 were made by means of Orsat Analysis. In this section the results obtained from these manual measurements are compared with the results obtained from the continuous measurement system, and, where appropriate, a comparison is made with theoretical expected gas concentrations.

The first of the comparisons is provided in Table 37. In Table 37, the manual measurements, continuous measurement results, and theoretical gas concentrations are provided for SO_2 in ppm as measured at location 1 and location 2. Where no values are shown, a measurement was not possible because of equipment failure or loss or contamination of the sample. The theoretical SO_2 values shown in Table 37 are based upon the standard methods for estimating stack gas products as described in the "Manual for Process Engineering Calculations" by Clarke and Davidson. The theoretical SO_2 values shown for location 3 were based upon the assumption that there is a 15% leakage between location 1 and location 3. The values for SO_2 at location 2 are therefore 85% of the theoretical values shown for location 2.

A comparison of continuous and manual measurements for NO_x in ppm is provided in Table 38 for location 3. The manual measurement results for NO_x are also provided in Table 38 for location 2. These results from location 2 are presented for the purpose of comparison with the results

TABLE 37

COMPARISON OF CONTINUOUS AND MANUAL SO_2 AT LOCATIONS 1 AND 3 WITH THEORETICAL VALUES

DATE	MITRE TEST NUMBER	TEST CONDITIONS					LOCATION 1		THEORETICAL SO_2 AT LOCATION 1	LOCATION 3		THEORETICAL SO_2 AT LOCATION 3
		LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE	MANUAL	CONT.		MANUAL	CONT.	
11/8/71	11	100	A	NO	NORM.	NORM.		2055.0				
11/9/71	9	100	A	NO	MIN.	NORM.		2220.0				
11/10/71	8	100	A	NO	MAX.	NORM.	2541.3	2216.3	2075	1306		1764
11/11/71	12	100	A	YES*	NORM.	NORM.	1884.4	2281.9	2211	1703	1755.0	1879
11/12/71	7	100	A	YES	NORM.	NORM.	1571.1	2393.6	2340	1800	2042.1	1989
11/15/71	1	75	B	NO	NORM.	NORM.	1582.1	2074.1	1957	1854	1905	1663
11/16/71	6	100	B	NO	NORM.	NORM.	1272.8	1997.1	1949	1767	1897.5	1657
11/17/71	18	50	B	YES	NORM.	NORM.	1569.0	1715.0	1480	1154	1479.0	1258
11/18/71	13	35	B	NO	NORM.	NORM.	1847.5	1632.1	1366	752	1371.0	1161
11/19/71	4	75	A	NO	MIN.	NORM.	1995.8	2307.3	2551	1917	2080.0	2168
11/22/71	5	75	C	NO	NORM.	NORM.	538.8	352.5	888	443	630.0	755
11/23/71	10	100	C	YES	NORM.	NORM.	561.7	387.9	683	426	536.3	580
11/24/71	20	50	C	NO	NORM.	NORM.	546.5	471.9	627	386	566.3	533
11/30/71	2	75	A	NO	NORM.	NORM.	1812.9	1938.8	2098	1429	1740.0	1783
12/1/71	3	75	A	NO	MAX.	NORM.	1762.2	2141.3	2220	1305	1875.0	1887
12/2/71	17	50	A	YES	NORM.	NORM.	1543.9	2085.0	2480		1980.0	2108
12/3/71	19	50	A	NO	MAX.	NORM.	1732.6	1897.5	2070	861	1815.0	1759
12/4/71	21	35	A	NO	NORM.	NORM.	1415.2	1875.0	2221	451	1680.0	1888
12/7/71	14	50	A	NO	NORM.	MIN.		1743.8			1782.9	
12/8/71	15	50	A	NO	MIN.	NORM.		2107.5				
12/9/71	22	75	D	NO	NORM.	NORM.		735.0			2062.5	

* REDUCED LEVEL OF SOOT BLOWING

TABLE 38

COMPARISON OF CONTINUOUS AND MANUAL NO_x AT LOCATION 3

DATE	MITRE TEST NO. (OLD)	TEST CONDITIONS							MANUAL NO_x LOCATION 2	MANUAL NO_x LOCATION 3	CONTINUOUS NO MEASUREMENTS LOCATION 3
		LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	MEASURED EXCESS AIR		BURNER ANGLE			
						LOCATION 2	LOCATION 3				
11/8/71	11	100	A	NO	NORM.	81.5	64.2	NORM.	397	651	
11/9/71	9	100	A	NO	MIN.	64.2	36.6	NORM.	304	378	
11/9/71	9	100	A	NO	MIN.	64.2	36.6	NORM.	390	411	
11/10/71	8	100	A	NO	MAX.	59.6	47.3	NORM.	433	453	
11/10/71	8	100	A	NO	MAX.	59.6	47.3	NORM.		591	
11/11/71	12	100	A	YES*	NORM.	43.2	60.5	NORM.	513	349	
11/11/71	12	100	A	YES*	NORM.	43.2	60.5	NORM.	505	436	
11/12/71	7	100	A	YES	NORM.	38.6	38.3	NORM.	287	321	
11/12/71	7	100	A	YES	NORM.	38.6	38.3	NORM.	363	437	
11/16/71	6	100	B	NO	NORM.	42.7	40.3	NORM.	447	466	
11/16/71	6	100	B	NO	NORM.	42.7	40.3	NORM.	481	466	285
11/15/71	1	75	B	NO	NORM.	61.9	57.4	NORM.	464	419	350
11/15/71	1	75	B	NO	NORM.	61.9	57.4	NORM.	463	461	395
11/17/71	18	50	B	YES	NORM.	72.5	58.5	NORM.	246	570	
11/17/71	18	50	B	YES	NORM.	72.5	58.5	NORM.	485	684	365
11/18/71	13	35	B	NO	NORM.	87.8	69.3	NORM.	464	387	
11/18/71	13	35	B	NO	NORM.	87.8	69.3	NORM.	587	443	335
11/19/71	4	75	A	NO	MIN.	30.7	27.4	NORM.	319	330	375
11/19/71	4	75	A	NO	MIN.	30.7	27.4	NORM.	385	271	333
11/22/71	5	75	C	NO	NORM.	35.4	42.5	NORM.	339	308	240
11/22/71	5	75	C	NO	NORM.	35.4	42.5	NORM.	328		
11/23/71	10	100	C	YES	NORM.	52.7	41.3	NORM.	223	367	100
11/23/71	10	100	C	YES	NORM.	52.7	41.3	NORM.	243	264	105
11/24/71	20	50	C	NO	NORM.	30.3	34.4	NORM.	279	235	150
11/24/71	20	50	C	NO	NORM.	30.3	34.4	NORM.	267	262	145
11/30/71	2	75	A	NO	NORM.	35.0	36.8	NORM.	467	412	345
11/30/71	2	75	A	NO	NORM.	35.0	36.8	NORM.	552	450	335
12/1/71	3	75	A	NO	MAX.	47.1	52.5	NORM.	294	426	
12/1/71	3	75	A	NO	MAX.	47.1	52.5	NORM.	410	558	340
12/2/71	17	50	A	YES	NORM.	38.5	38.3	NORM.	341	323	
12/2/71	17	50	A	YES	NORM.	38.5	38.3	NORM.	347	295	345
12/3/71	19	50	A	NO	MAX.	64.3	69.3	NORM.	436	406	
12/3/71	19	50	A	NO	MAX.	64.3	69.3	NORM.	358	403	
12/4/71	21	35	A	NO	NORM.	51.7	61.2	NORM.	344	368	
12/4/71	21	35	A	NO	NORM.	51.7	61.2	NORM.	389	276	195

* REDUCED LEVEL OF SOOT BLOWING

at location 3. A comparison with continuous measurements is not provided since continuous NO_x measurements were not taken at location 2. Theoretical values for NO_x were not presented since there is no convenient algorithm for estimating NO_x concentrations as a function of fuel and operating parameters. As noted in Table 38, the continuous measurement results at location 3 are reported in terms of NO concentration rather than the total NO_x levels. These NO results do, however, represent a close approximation of the total NO_x levels since the NO_2 results were considered to be of small magnitude and close to the noise level of the instrument.

A comparison of continuous O_2 and CO_2 measurements and Orsat measurements is provided for location 3 in Table 39. The values shown in Table 39 are in terms of decimal fractions (i.e., .075 equals 7.5%). Grab samples of CO_2 were also taken at location 1 and location 3 for laboratory analysis. However, subsequent to the Baseline Test, it was determined that these sample containers had leaked and the analytical results were therefore invalid.

Grab samples of CO were taken at location 1 and location 3 for laboratory analysis. No evidence of CO was found in the grab samples and in addition no evidence of CO was found in the readings of the continuous measurement CO monitor located in the stack.

Analysis and Interpretation of Results

As noted on Table 37, there were several tests for which data were not available from the manual and/or the continuous measurement methods for SO_2 analysis (due to either equipment failure or loss of sample). For those tests where data were available from both the manual and continuous measurements a comparison shows that at location 1 the average of the manual samples is 82% of the average of the theoretical values. For these same tests, the average of the continuous measurements is 95% of the average of the theoretical values. The extremes of the manual measurements occur in test 5 where the manual value is 61% of the theoretical value, and test 13 where the manual value is 135% of the

TABLE 39

COMPARISON OF CONTINUOUS O_2 AND CO_2 WITH ORSAT MEASUREMENTS AT LOCATION 3

DATE	MITRE TEST NUMBER	TEST CONDITIONS					O_2		CO_2	
		LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE	CONT.	ORSAT	CONT.	ORSAT
11/8/71	11	100	A	NO	NORM.	NORM.	----	.084	----	.108
11/9/71	9	100	A	NO	MIN.	NORM.	----	.058	----	.128
11/10/71	8	100	A	NO	MAX.	NORM.	----	.070	----	.110
11/11/71	12	100	A	YES*	NORM.	NORM.	----	.080	----	.1225
11/12/71	7	100	A	YES	NORM.	NORM.	.0625	.060	.135	.125
11/15/71	1	75	B	NO	NORM.	NORM.	.071	.078	.141	.118
11/16/71	6	100	B	NO	NORM.	NORM.	.0675	.062	.138	.126
11/17/71	18	50	B	YES	NORM.	NORM.	.075	.079	.1355	.116
11/18/71	13	35	B	NO	NORM.	NORM.	.0852	.088	.128	.104
11/19/71	4	75	A	NO	MIN.	NORM.	.062	.047	.142	.131
11/22/71	5	75	C	NO	NORM.	NORM.	.032	.065	.124	.103
11/23/71	10	100	C	NO	NORM.	NORM.	.060	.065	.1311	.099
11/24/71	20	50	C	NO	NORM.	NORM.	.0706	.057	.1264	.106
11/30/71	2	75	A	NO	NORM.	NORM.	.0615	.058	.140	.131
12/1/71	3	75	A	NO	MAX.	NORM.	.0807	.074	.132	.118
12/2/71	17	50	A	YES	NORM.	NORM.	.074	.066	.1348	.126
12/3/71	19	50	A	NO	MAX.	NORM.	.086	.088	.126	.104
12/4/71	21	35	A	NO	NORM.	NORM.	.0776	.082	.125	.106
12/7/71	14	50	A	NO	NORM.	MIN.	.0705	.061	.1411	.126
12/8/71	15	50	A	NO	MIN.	NORM.	.0695	.067	.138	.122
12/9/71	22	75	D	NO	NORM.	NORM.	.0565	.063	.1362	.126

* REDUCED LEVEL OF SOOT BLOWING

theoretical value. The extremes for the continuous measurement at location 1 occur in test 5 where the continuous measurement is 40% of the theoretical value and test 13 where the continuous measurement is 119% of the theoretical value.

At location 3, the average of the manual measurements is 76% of the average of the theoretical values for the tests having both manual and continuous measurements. For these same tests, the average of the continuous measurement is 100% of the average of the theoretical values. The extremes for the manual measurements occur in test 21 where the manual value is 24% of the theoretical value and test 1 where the manual value is 111% of the theorectical value. The extremes for the continuous measurement occur in test 21 where the continuous measurement is 89% of the theoretical value and test 1 where the continuous measurement is 114% of the theoretical value.

Table 38 provides a comparison of the continuous and manual measurements for NO_x at location 3. Manual measurements taken at location 2 are also provided in this Table. No consistent patterns are noted in Table 38 with respect to the effect of test conditions on NO_x concentrations, with the exception of fuel type. For the test performed with C fuel (gas and coal mixed) the NO_x levels were significantly lower than for the tests performed with A and B fuel.

A comparison of continuous O_2 and CO_2 measurements and Orsat measurements is provided in Table 39. A comparison of the average of the continuous O_2 and the Orsat O_2 measurements shows good agreement whereas the average of the continuous CO_2 measurements were higher than the average of the Orsat CO_2 measurements.

ANALYSES OF COAL, PULVERIZER REJECTS, FURNACE BOTTOM ASH, AND FLY ASH

Results of Ultimate and Proximate Analyses

As indicated in Table 5 in Section 2, ultimate and proximate analyses of pulverized coal from the coal mills were performed for each of the 21 tests in the Baseline Program. These analyses were performed both on an "as received" basis and on a "dry" basis. The analyses were performed by two separate laboratories, the Industrial Testing Laboratories (subcontractor to the Midwest Research Institute) and the Illinois Geological Survey. The results from the laboratories were then averaged as shown in Table 40 and Table 41. The first and second digit of the sample number shown on these Tables and on subsequent Tables correspond to the MITRE test numbers (i.e., CS 01002 corresponds to a coal sample from MITRE test number 1).

Proximate analyses were also performed on samples of fly ash removed from the dust collector and the air heater. These analyses were performed by the Industrial Testing Laboratories (subcontractor to the Midwest Research Institute) for selected tests in the program and are summarized in Table 42 and 43.

Proximate analyses were also performed on samples of ash taken from the furnace bottom (slag samples) and from the pulverizer reject chute on the coal mills. The results of these analyses as reported by the Industrial Testing Laboratories are summarized in Table 44 and Table 45.

Results of Elemental Analyses

Trace element concentrations were determined on four of the tests in the Baseline Program in the coal pulverizer rejects from the coal mills; bottom ash (slag); and the fly ash collected in the air heater, the mechanical collector, and locations 2 and 3. The results of these analyses are summarized in Tables 46, 47, 48, and 49.

Trace element concentrations were also determined for samples of fly ash collected from location 2 and location 3, for four tests in the program. The results of these analyses are summarized in Tables 50 through Table 54.

Additional trace elemental analyses were provided by EPA on pulverized coal for six of the test runs as summarized in Table 55.

Except for Table 55, which provides the results as parts-per-million, all results of the elemental analyses are reported in terms of weight percent. In the case of the analysis of fly ash at location 3, the results must be multiplied with the fly ash emission rate to determine emission rates to the ambient atmosphere.

TABLE 40

PROXIMATE AND ULTIMATE ANALYSES OF COAL

SAMPLE NUMBER	DRY BASIS									
	PROXIMATE ANALYSES			ULTIMATE ANALYSES						
	ASH	VOLATILE MATTER	FIXED CARBON	CARBON	HYDROGEN	NITROGEN	SULFUR	OXYGEN	HEATING VALUE, BTU/LB.	SOURCE OF ANALYSIS
CS01002	10.86	38.74	50.40	70.25	4.94	1.39	3.23	9.33	12,624	ITL*
	11.0	41.2	47.8	70.07	4.89	1.32	3.35	9.39	12,632	ISGS**
	10.9	40.0	49.1	70.16	4.92	1.36	3.29	9.36	12,628	AVERAGE
CS02002	10.32	37.85	51.83	71.30	4.85	1.22	3.01	9.30	12,664	ITL
	10.7	40.6	48.6	70.41	4.88	1.41	2.99	9.60	12,655	ISGS
	10.5	39.2	50.2	70.86	4.87	1.32	3.00	9.45	12,660	AVERAGE
CS03002	10.43	38.07	51.50	70.69	4.79	1.31	3.44	9.34	12,138	ITL
	10.7	41.2	48.1	70.29	4.85	1.40	3.46	9.35	12,656	ISGS
	10.6	39.6	49.8	70.49	4.82	1.36	3.45	9.35	12,397	AVERAGE
CS04002	10.82	38.45	50.74	70.79	4.92	1.36	3.48	8.63	12,630	ITL
	11.1	40.0	48.9	70.15	4.86	1.39	3.55	8.93	12,546	ISGS
	11.0	39.2	49.8	70.47	4.89	1.38	3.52	8.78	12,588	AVERAGE
CS05002	14.09	35.21	50.70	69.28	4.74	1.52	1.89	8.48	12,267	ITL
	14.8	37.0	48.2	68.19	4.55	1.36	1.91	9.21	12,151	ISGS
	14.4	36.1	49.5	68.74	4.65	1.44	1.90	8.84	12,209	AVERAGE
CS06002	11.8	40.4	47.9	70.10	4.85	1.30	2.88	9.09	12,570	ITL
CS07002	10.42	38.62	50.96	71.99	4.93	1.31	3.40	7.95	12,645	ITL
	10.2	41.6	48.2	70.48	4.81	1.23	3.42	9.82	12,694	ISGS
	10.3	40.1	49.6	71.24	4.87	1.27	3.41	8.89	12,670	AVERAGE
CS08002	10.64	38.53	50.83	71.54	4.97	1.28	3.50	8.07	12,625	ITL
	10.8	40.9	48.3	69.97	4.87	1.28	3.51	9.62	12,613	ISGS
	10.7	39.7	49.6	70.76	4.92	1.28	3.51	8.85	12,619	AVERAGE
CS09002	10.27	38.67	51.06	71.86	5.02	1.37	3.50	7.98	12,697	ITL
	10.3	40.7	49.0	70.21	4.73	1.27	3.57	9.93	12,677	ISGS
	10.3	39.7	50.0	71.04	4.88	1.32	3.54	8.96	12,687	AVERAGE
CS10002	17.26	33.04	49.70	66.46	4.42	1.48	1.71	8.67	11,719	ITL
CS11002	10.43	39.23	50.34	70.93	4.95	1.31	3.47	8.91	12,595	ITL
	10.3	41.6	48.1	70.52	4.80	1.26	3.54	9.55	12,656	ISGS
	10.4	40.4	49.2	70.73	4.88	1.29	3.51	9.23	12,626	AVERAGE
CS12002	11.15	37.79	51.06	70.22	4.84	1.30	3.31	9.18	12,500	ITL
	10.8	41.3	47.9	69.92	4.83	1.26	3.41	9.77	12,588	ISGS
	11.0	39.5	49.5	70.07	4.84	1.28	3.36	9.48	12,544	AVERAGE
CS13002	13.60	35.95	50.45	68.82	4.73	1.39	2.58	8.88	12,260	ITL
	14.2	38.5	47.3	67.99	4.59	1.33	2.62	9.25	12,148	ISGS
	13.9	37.2	48.9	68.41	4.66	1.36	2.60	9.07	12,204	AVERAGE
CS14002	11.30	37.13	51.57	70.58	4.77	1.39	2.87	9.09	12,641	ITL
	11.5	40.5	48.1	70.10	4.87	1.32	2.88	9.37	12,561	ISGS
	11.4	38.8	49.8	70.34	4.82	1.36	2.88	9.23	12,601	AVERAGE

* INDUSTRIAL TESTING LABORATORIES

** ILLINOIS STATE GEOLOGICAL SURVEY

TABLE 40 (CONCLUDED)

PROXIMATE AND ULTIMATE ANALYSES OF COAL

	DRY BASIS									
	PROXIMATE ANALYSES			ULTIMATE ANALYSES						
SAMPLE NUMBER	ASH	VOLATILE MATTER	FIXED CARBON	CARBON	HYDROGEN	NITROGEN	SULFUR	OXYGEN	HEATING VALUE, BTU/LB.	SOURCE OF ANALYSIS
CS15002	10.91	38.50	50.59	70.53	4.81	1.36	3.61	8.78	12,557	ITL
	10.6	41.3	48.1	70.83	4.86	1.35	3.45	8.92	12,631	ISGS
	10.8	39.9	49.3	70.68	4.83	1.36	3.53	8.85	12,594	AVERAGE
CS17002	10.58	38.95	50.47	70.58	4.83	1.17	3.57	9.27	12,637	ITL
	10.4	41.5	48.1	70.73	4.84	1.36	3.65	9.01	12,681	ISGS
	10.4	40.2	49.3	70.66	4.84	1.27	3.61	9.14	12,659	AVERAGE
CS18002	12.64	36.31	51.05	69.71	4.78	1.55	2.61	8.71	12,299	ITL
	12.7	38.8	48.5	69.49	4.62	1.40	2.73	9.05	12,347	ISGS
	12.7	37.6	49.8	69.60	4.70	1.48	2.67	8.88	12,323	AVERAGE
CS19002	9.97	39.62	50.41	71.09	4.86	1.18	3.54	9.36	12,732	ITL
	10.2	42.3	47.4	71.41	4.91	1.33	3.72	8.41	12,730	ISGS
	10.1	41.0	48.9	71.25	4.89	1.26	3.63	8.89	12,731	AVERAGE
CS20002	16.61	32.85	50.54	67.52	4.45	1.36	1.75	8.31	11,654	ITL
CS21002	9.52	56.43	34.05	71.72	4.87	1.39	3.15	9.35	12,858	ITL
	9.4	41.6	49.0	72.07	4.97	1.33	3.31	8.97	12,821	ISGS
	9.5			71.90	4.92	1.36	3.23	9.16	12,840	AVERAGE
CS22002	6.94	35.46	57.60	75.85	4.97	1.75	1.39	9.13	13,413	ITL
	6.7	37.4	55.9	76.13	4.93	1.62	1.41	9.20	13,393	ISGS
	6.8	36.4	56.8	76.00	4.95	1.69	1.40	9.17	13,403	AVERAGE

TABLE 41

PROXIMATE AND ULTIMATE ANALYSES OF COAL

SAMPLE NUMBER	AS RECEIVED BASIS										
	PROXIMATE ANALYSES				ULTIMATE ANALYSES						
	MOISTURE	ASH	VOLATILE MATTER	FIXED CARBON	CARBON	HYDROGEN	NITROGEN	SULFUR	OXYGEN	HEATING VALUE, BTU/LB.	SOURCE OF ANALYSIS
CS01002	4.02	10.42	37.18	48.38	67.43	5.19	1.33	3.10	12.53	12,117	ITL*
	4.2	10.5	39.5	45.8	67.13	5.15	1.27	3.21	12.73	12,101	ISGS**
	4.1	10.5	38.3	47.1	67.3	5.17	1.30	3.16	12.63	12,109	AVERAGE
CS02002	4.52	9.85	36.14	49.49	68.08	5.13	1.16	2.87	12.99	12,092	ITL
	4.3	10.3	38.9	46.5	67.39	5.15	1.35	2.86	13.01	12,111	ISGS
	4.4	10.1	37.5	48.0	67.74	5.14	1.26	2.87	13.00	12,102	AVERAGE
CS03002	4.13	10.00	36.50	49.37	67.77	5.05	1.26	3.30	12.62	12,138	ITL
	4.0	10.2	39.6	46.2	67.48	5.10	1.34	3.32	12.53	12,149	ISGS
	4.1	10.1	38.1	47.8	67.63	5.08	1.30	3.31	12.58	12,144	AVERAGE
CS04002	4.31	10.35	36.79	48.55	67.74	5.19	1.30	3.33	12.09	12,086	ITL
	4.2	10.6	38.3	46.8	67.20	5.13	1.33	3.40	12.29	12,020	ISGS
	4.3	10.5	37.5	46.7	67.47	5.16	1.32	3.37	12.19	12,053	AVERAGE
CS05002	3.69	13.57	33.91	48.83	66.72	4.98	1.46	1.82	11.45	11,814	ITL
	3.6	14.3	35.7	46.4	65.73	4.79	1.31	1.84	12.08	11,713	ISGS
	3.6	13.9	34.8	47.6	66.23	4.89	1.39	1.83	11.77	11,764	AVERAGE
CS06002	4.1	11.3	38.7	45.9	67.22	5.10	1.24	2.76	12.36	12,055	ISGS
CS07002	3.89	10.01	37.12	48.98	69.19	5.17	1.26	3.27	11.10	12,153	ITL
	4.0	9.8	39.9	46.3	67.66	5.07	1.18	3.28	12.98	12,186	ISGS
	3.9	9.9	38.5	47.6	68.43	5.12	1.22	3.28	12.04	12,170	AVERAGE
CS08002	3.66	10.25	37.12	48.97	68.92	5.19	1.23	3.37	11.04	12,163	ITL
	4.0	10.3	39.3	46.4	67.17	5.12	1.22	3.37	12.79	12,109	ISGS
	3.8	10.3	38.2	47.7	68.05	5.16	1.23	3.37	11.92	12,136	AVERAGE
CS09002	3.66	9.89	37.26	49.19	69.23	5.24	1.32	3.37	10.95	12,163	ITL
	4.0	9.9	39.1	47.0	67.40	4.99	1.22	3.43	13.08	12,169	ISGS
	3.8	9.9	38.2	48.1	68.32	5.12	1.27	3.40	12.02	12,201	AVERAGE
CS10002	3.29	16.69	31.95	48.07	64.27	4.64	1.43	1.65	11.32	11,333	ITL
CS11001	3.84	10.03	37.22	48.41	68.19	5.20	1.26	3.34	11.98	12,111	ITL
	4.3	9.9	39.8	46.0	67.49	5.07	1.21	3.39	12.96	12,112	ISGS
	4.1	10.0	38.5	47.2	67.84	5.14	1.24	3.37	12.47	12,112	AVERAGE

* INDUSTRIAL TESTING LABORATORIES

** ILLINOIS STATE GEOLOGICAL SURVEY

TABLE 41 (CONCLUDED)

PROXIMATE AND ULTIMATE ANALYSES OF COAL

SAMPLE NUMBER	AS RECEIVED BASIS										SOURCE OF ANALYSIS
	MOISTURE	ASH	VOLATILE MATTER	FIXED CARBON	CARBON	HYDROGEN	NITROGEN	SULFUR	OXYGEN	HEATING VALUE, BTU/LB.	
CS12002	3.59	10.75	36.43	49.23	67.70	5.06	1.25	3.19	9.18	12,051	ITL
	3.9	10.4	39.7	46.0	67.19	5.07	1.22	3.28	12.85	12,097	ISGS
	3.7	10.6	38.1	47.6	67.45	5.07	1.24	3.24	11.01	12,080	AVERAGE
CS13002	3.45	13.13	34.71	48.71	66.45	4.95	1.34	2.49	11.64	11,837	ITL
	3.8	13.7	37.0	45.5	65.41	4.83	1.28	2.52	12.28	11,686	ISGS
	3.6	13.4	35.9	47.1	65.93	4.89	1.31	2.51	11.96	11,762	AVERAGE
CS14002	4.58	10.78	35.43	49.21	67.35	5.06	1.33	2.74	12.74	12,062	ITL
	4.4	11.0	38.7	45.9	67.01	5.15	1.26	2.75	12.87	12,009	ISGS
	4.5	10.9	37.1	47.6	67.18	5.11	1.30	2.74	12.91	12,034	AVERAGE
CS15002	4.30	10.44	36.84	48.42	67.50	5.08	1.30	3.45	12.23	12,017	ITL
	4.6	10.1	39.4	45.9	67.57	5.15	1.29	3.29	12.60	12,050	ISGS
	4.5	10.3	38.1	47.2	67.54	5.12	1.29	3.37	12.42	12,034	AVERAGE
CS17002	4.12	10.14	37.35	48.39	67.67	5.09	1.12	3.42	12.56	12,116	ITL
	4.4	9.9	39.7	45.9	67.62	5.11	1.30	3.49	12.52	12,123	ISGS
	4.3	10.0	38.5	47.1	67.65	5.10	1.21	3.46	12.54	12,120	AVERAGE
CS18002	3.88	12.15	34.90	49.07	67.00	5.03	1.49	2.51	11.82	11,813	ITL
	4.2	12.2	37.2	46.4	66.57	4.90	1.35	2.62	12.40	11,829	ISGS
	4.0	12.2	36.1	47.7	66.79	4.97	1.42	2.57	12.11	11,821	AVERAGE
CS19002	4.08	9.56	38.00	48.36	68.19	5.12	1.13	3.39	12.61	12,213	ITL
	4.6	9.8	40.4	45.2	68.12	5.20	1.27	3.55	12.11	12,144	ISGS
	4.3	9.7	39.2	46.8	68.16	5.16	1.20	3.47	12.36	12,179	AVERAGE
CS20002	4.04	15.94	31.53	48.50	64.80	4.72	1.30	1.68	11.56	11,184	ITL
CS21002	4.00	9.14	54.17	32.69	68.85	5.12	1.33	3.02	12.54	12,344	ITL
	4.6	8.9	39.7	46.8	68.75	5.25	1.27	3.16	12.65	12,231	ISGS
	4.3	9.1			68.80	5.19	1.30	3.09	12.60	12,288	
CS22002	4.71	6.61	33.79	54.89	72.28	5.23	1.67	1.32	12.89	12,781	ITL
	5.0	6.4	35.5	53.1	72.32	5.24	1.54	1.34	13.18	12,724	ISGS
	4.9	6.5	34.6	54.0	72.30	5.24	1.61	1.33	13.04	12,753	AVERAGE

TABLE 42

PROXIMATE ANALYSIS OF FLY ASH FROM DUST COLLECTOR

SAMPLE NUMBER	AS RECEIVED						DRY BASIS				
	PROXIMATE ANALYSIS, %						PROXIMATE ANALYSIS, %				
	MOISTURE	ASH	VOLATILE MATTER	FIXED CARBON	SULFUR	HEATING VALUE, BTU/LB.	ASH	VOLATILE MATTER	FIXED CARBON	SULFUR	HEATING VALUE, BTU/LB.
SA01004	0.16	99.61	0.78	--	0.38	20	99.77	0.78	--	0.38	20
SA03004	0.19	99.00	1.11	--	0.26	30	99.19	1.11	--	0.26	30
SA05004	0.10	99.02	0.91	--	0.30	48	99.12	0.91	--	0.30	48
SA06004	0.23	99.29	0.86	--	0.26	0	99.52	0.86	--	0.26	0
SA08004	0.11	98.62	1.86	--	0.61	91	98.77	1.86	--	0.61	91
SA10004	0.15	99.14	0.72	--	0.36	12	99.30	0.72	--	0.36	12
SA13004	0.24	97.61	1.13	1.02	0.53	80	97.84	1.13	1.02	0.53	80
SA18004	0.23	98.95	0.80	0.02	0.41	0	99.18	0.80	0.02	0.41	0
SA20004	0.16	97.46	0.29	2.09	0.30	146	97.62	0.29	2.09	0.30	146
SA21004	0.25	97.38	1.85	0.52	0.66	148	97.62	1.85	0.53	0.66	148
SA22004	0.16	97.69	0.87	1.28	0.27	167	97.85	0.87	1.28	0.27	167

TABLE 43

PROXIMATE ANALYSIS OF AIR HEATER HOPPER ASH

SAMPLE NUMBER	AS RECEIVED						DRY BASIS				
	PROXIMATE ANALYSIS, %						PROXIMATE ANALYSIS, %				
	MOISTURE	ASH	VOLATILE MATTER	FIXED CARBON	SULFUR	HEATING VALUE, BTU/LB.	ASH	VOLATILE MATTER	FIXED CARBON	SULFUR	HEATING VALUE, BTU/LB.
SA01002	0.26	98.52	1.72	--	0.52	168	98.78	1.72	--	0.52	168
SA05002	0.18	98.82	2.26	--	0.84	68	99.00	2.26	--	0.84	68
SA06002	0.12	99.21	2.12	--	0.67	46	99.33	2.12	--	0.67	46
SA08002	0.17	98.43	2.79	--	0.74	120	98.60	2.79	--	0.74	120
SA10002	0.19	97.78	2.38	--	0.39	195	97.97	2.38	--	0.39	195
SA13002	0.19	98.03	0.94	0.84	0.61	143	98.22	0.94	0.84	0.61	143
SA18002	0.20	98.17	1.10	0.53	0.39	135	98.37	1.10	0.53	0.39	135
SA21002	0.25	98.13	1.36	0.26	0.58	120	98.38	1.36	0.26	0.58	120
SA22002	0.21	97.17	1.76	0.86	0.57	271	97.37	1.76	0.87	0.57	272

TABLE 44

PROXIMATE ANALYSIS OF SLAG SAMPLES

SAMPLE NUMBER	AS RECEIVED						DRY BASIS				
	PROXIMATE ANALYSIS, %						PROXIMATE ANALYSIS, %				
	MOISTURE	ASH	VOLATILE MATTER	FIXED CARBON	SULFUR	HEATING VALUE, BTU/LB.	ASH	VOLATILE MATTER	FIXED CARBON	SULFUR	HEATING VALUE, BTU/LB.
PA01001	10.32	86.74	2.11	0.83	0.48	374	96.72	2.35	0.93	0.53	417
PA03001	34.24	63.52	1.66	0.58	0.39	241	96.60	2.52	0.88	0.59	366
PA05001	11.53	88.26	0.38	--	0.03	13	99.76	0.43	--	0.05	15
PA10001	36.85	61.74	1.19	0.22	0.12	145	97.77	1.88	0.35	0.19	230
PA21001	40.56	58.00	1.08	0.36	0.24	113	97.58	1.81	0.61	0.41	190
PA22001	35.83	63.93	0.19	0.05	0.14	16	99.62	0.30	0.08	0.22	25

TABLE 45

PROXIMATE ANALYSIS OF PULVERIZER REJECT SAMPLES

SAMPLE NUMBER	AS RECEIVED						DRY BASIS				
	PROXIMATE ANALYSIS, %						PROXIMATE ANALYSIS, %				
	MOISTURE	ASH	VOLATILE MATTER	FIXED CARBON	SULFUR	HEATING VALUE, BTU/LB.	ASH	VOLATILE MATTER	FIXED CARBON	SULFUR	HEATING VALUE, BTU/LB.
RJ01001	0.81	54.26	20.88	24.05	26.07	4,567	54.70	21.05	24.25	26.28	4,604
RJ03001	1.28	50.93	10.45	37.34	27.61	4,994	51.59	10.59	37.82	27.97	5,059
RJ05001	3.90	33.94	26.72	15.44	16.95	8,143	35.15	27.67	15.99	17.56	8,434
RJ10001	3.40	38.94	24.51	33.15	11.27	7,521	40.31	25.37	34.32	11.67	7,786
RJ21001	0.78	53.19	15.21	30.82	20.86	4,354	53.61	15.33	31.06	21.02	4,388
RJ22001	0.54	51.11	18.48	29.87	20.68	4,794	51.39	18.58	30.03	20.79	4,820

TABLE 46

COMPARISON OF ELEMENTAL CONCENTRATIONS IN COAL, PULVERIZER REJECTS, SLAG, AND FLY ASH
(MITRE TEST NO. 1, 75 MW, B FUEL, NO SOOT BLOWING, NORMAL EXCESS AIR, NORMAL BURNER ANGLE)

	ELEMENTAL CONTENT BY WEIGHT (WEIGHT PERCENT)						
ELEMENT	PULVERIZED COAL, CS01002*	PULVERIZER REJECTS, RJ01001*	SLAG, PA01001*	FLY ASH FROM AIR HEATER ASH HOPPER, SA01002*	FLY ASH FROM MECHANICAL SEPARATOR, SA01004*	FLUE GAS PARTICULATES, LOCATION 2, AIR HEATER, DUCT, 206-2**	FLUE GAS PARTICULATES, LOCATION 3, STACK, 206-3**
Al	0.960	0.490	9.25	7.20	8.05	9.40	9.24
Ba	<0.03	<0.03	0.3	0.02	0.03	<0.04	<0.04
Be	<0.0002	<0.0002	0.0004	0.001	0.0008	0.001	0.001
Ca	0.250	1.61	3.45	4.88	1.96	2.38	0.970
Cd	0.0006	0.0004	<0.005	0.0009	0.002	0.016	0.002
Co	0.000	<0.003	0.006	0.004	0.004	0.006	0.007
Cr	0.002	0.002	0.016	0.010	0.013	0.05	0.740
Cu	0.002	0.003	0.007	0.008	0.007	0.010	0.020
Fe	0.995	13.1	16.2	14.8	10.7	11.7	11.1
Ga	0.08	<0.07	<0.02	<0.07	<0.08	<0.06	<0.06
Ge	0.0	0.0	<0.07	0.0	0.0	0.0	0.0
Hg	<0.0002	0.00006	0.0003	0.00003	0.00004	<0.00002	0.002
K	0.155	0.127	1.48	1.48	1.80	1.84	2.36
Mg	0.073	0.071	0.519	0.500	0.280	0.620	0.660
Mn	0.009	0.007	0.057	0.090	0.036	0.050	0.080
Mo	<0.002	<0.002	0.00	<0.002	0.002	<0.003	<0.003
Na	0.06	0.044	0.379	0.270	0.460	0.590	2.06
Ni	0.009	0.0009	0.013	0.010	0.040	0.05	0.200
Pb	<0.003	<0.003	0.009	0.003	<0.003	0.020	0.020
Sb	<0.07	<0.07	0.06	<0.06	<0.07	<0.06	<0.06
Se	<0.06	<0.06	<0.05	<0.06	<0.07	<0.05	<0.05
Sn	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05
Sr	<0.0005	<0.0005	0.004	0.004	0.003	0.003	<0.001
Ti	<0.098	<0.094	1.31	0.380	0.550	0.580	0.660
Tl	<0.01	0.006	0.008	0.006	<0.01	0.010	0.005
V	<0.02	<0.02	0.04	<0.02	<0.02	0.02	0.03
Zn	0.11	0.011	0.038	0.040	0.057	0.59	0.090

* MITRE SAMPLE NUMBER

** MIDWEST RESEARCH INSTITUTE SAMPLE NUMBER

TABLE 47

COMPARISON OF ELEMENTAL CONCENTRATIONS IN COAL, PULVERIZER REJECTS, SLAG & FLY ASH (MITRE TEST NO. 3, 75 MW, A FUEL, NO SOOT BLOWING, MAXIMUM EXCESS AIR, NORMAL BURNER ANGLE)

ELEMENTAL CONTENT BY WEIGHT (WEIGHT PERCENT)				
ELEMENT	PULVERIZED COAL, CS03002*	PULVERIZER REJECT, RJ03001*	SLAG, PA03001*	FLY ASH FROM MECHANICAL SEPARATOR, SA03004
Al	0.900	0.900	8.50	8.60
Ba	<0.2	<0.2	0.3	0.3
Be	<0.0002	<0.0002	0.0004	0.0008
Ca	0.480	0.210	4.27	3.30
Cd				
Co	<0.005	0.003	0.006	0.005
Cr	0.000	0.004	0.016	0.014
Cu	0.0005	0.003	0.007	0.008
Fe	1.24	19.3	16.8	12.2
Ga	<0.05	<0.03	<0.02	<0.03
Ge	<0.07	<0.07	<0.07	<0.07
Hg	0.00000	0.00000	0.00000	0.00004
K	0.165	0.150	1.36	1.50
Mg	0.055	0.050	0.575	0.512
Mn	0.006	0.010	0.082	0.060
Mo	0.00	0.00	0.00	0.00
Na	0.073	0.080	0.400	0.650
Ni	<0.002	0.002	0.012	0.015
Pb	<0.005	0.009	0.011	0.006
Sb	<0.05	0.04	0.06	0.03
Se	<0.09	<0.05	<0.05	0.04
Sn	<0.1	<0.01	<0.1	<0.1
Sr	<0.0005	0.0005	0.008	<0.003
Ti	0.060	0.050	1.15	1.34
Tl	<0.008	0.004	0.008	0.006
V	<0.04	<0.04	<0.04	<0.04
Zn	0.009	0.427	0.032	0.044

* MITRE SAMPLE NUMBER

TABLE 48

COMPARISON OF ELEMENTAL CONCENTRATIONS IN COAL, PYRITES, SLAG, AND FLY ASH
(MITRE TEST No. 22, 75 MW, D FUEL, NO SOOT BLOWING, NORMAL EXCESS AIR, NORMAL BURNER ANGLE)

	ELEMENTAL CONTENT BY WEIGHT (WEIGHT PERCENT)						
ELEMENT	PULVERIZED COAL, CS22002*	PULVERIZER REJECT, RJ22001*	SLAG, PA22001*	FLY ASH FROM AIR HEATER HOPPER, SA22002*	FLY ASH FROM MECHANICAL SEPARATOR, SA22004*	FLUE GAS PARTICULATES, LOCATION 2, AIR HEATER, 221-2**	FLUE GAS PARTICULATES, LOCATION 3, STACK, 221-3**
Al	0.600	0.500	8.40	6.40	9.50	10.0	9.50
Ba	<0.2	<0.2	0.4	0.4	<0.2	0.3	0.3
Be	<0.0002	<0.0002	0.0008	0.0006	0.001	0.001	0.002
Ca	0.250	1.28	4.55	7.90	1.78	2.09	1.33
Cd							
Co	<0.005	0.005	0.007	0.006	0.007	0.018	0.014
Cr	<0.002	0.004	0.018	0.020	0.023	0.342	0.626
Cu	0.0005	0.002	0.006	0.008	0.009	0.012	0.021
Fe	0.520	17.3	16.6	17.0	6.70	7.84	8.24
Ga	<0.05	<0.02	<0.02	<0.03	<0.03	<0.02	<0.02
Ge	<0.07	<0.07	<0.07	<0.007	<0.007	<0.07	<0.07
Hg	0.0001	0.00000	0.00000	0.00006	<0.00001	0.0004	0.0001
K	0.131	0.110	0.253	0.835	1.75	1.62	1.80
Mg	0.050	0.105	0.567	0.461	0.480	0.530	0.505
Mn	0.002	0.014	0.073	0.117	0.038	0.070	0.124
Mo	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Na	0.053	0.063	0.400	0.312	0.624	0.529	0.722
Ni	<0.002	0.001	0.010	0.013	0.026	0.165	0.390
Pb	<0.005	0.011	0.008	0.006	0.007	0.015	0.020
Sb	<0.05	0.04	0.02	0.03	0.03	0.03	0.04
Se	<0.09	0.08	<0.05	0.03	0.05	0.08	0.05
Sn	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sr	<0.0005	0.003	0.007	0.009	0.000	0.003	<0.0005
Ti	0.065	0.040	1.22	0.780	1.78	1.61	1.64
Tl	<0.008	0.006	0.008	0.004	0.004	0.01	0.008
V	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Zn	0.011	0.087	0.026	0.030	0.046	0.064	0.127

* MITRE SAMPLE NUMBER

** MIDWEST RESEARCH INSTITUTE SAMPLE NUMBER

TABLE 49

COMPARISON OF ELEMENTAL CONCENTRATIONS IN COAL, PULVERIZER REJECTS, AND FLY ASH (MITRE TEST NO. 5, 75 MW, C FUEL, NO SOOT BLOWING, NORMAL EXCESS AIR, NORMAL BURNER ANGLE)

ELEMENTAL CONTENT BY WEIGHT (WEIGHT PERCENT)							
ELEMENT	PULVERIZED COAL, CS05002*	PULVERIZER REJECT, RJ05001*	SLAG, PA05001*	FLY ASH FROM AIR HEATER HOPPER, SA05002*	FLY ASH FROM MECHANICAL SEPARATOR, SA05004	FLUE GAS PARTICULATES, LOCATION 2, AIR HEATER DUCT, 211-2**	FLUE GAS PARTICULATES, LOCATION 3, STACK, 211-3**
Al		1.55	10.2	7.20	10.15	9.56	7.35
Ba		0.00	<0.04	0.3	0.4	0.5	0.3
Be		<0.0002	0.0006	0.0004	0.0006	0.0008	0.0007
Ca		0.120	5.36	7.00	3.35	3.40	1.39
Cd		0.002	0.021				
Co		<0.004	0.004	0.007	0.006	0.014	0.016
Cr		0.000	0.009	0.025	0.013	0.249	1.08
Cu		0.002	0.009	0.010	0.009	0.011	0.016
Fe		2.30	9.43	19.7	6.63	7.27	10.8
Ga		<0.06	<0.06	<0.03	<0.03	0.03	<0.06
Ge		0.0	0.00	<0.007	<0.007	<0.07	<0.07
Hg		<0.00003	0.00002	0.00000	<0.00001	0.00005	0.00008
K		0.290	2.68	0.935	1.87	1.77	1.50
Mg		0.085	0.720	0.424	0.580	0.533	0.422
Mn		0.006	0.075	0.114	0.051	0.073	0.200
Mo		<0.003	<0.002	0.00	0.00	<0.04	0.00
Na		0.10	0.635	0.370	0.220	0.991	0.750
Ni		0.004	0.031	0.010	0.017	0.239	0.600
Pb		0.007	0.009	0.010	0.007	0.018	0.014
Sb		<0.06	<0.06	0.02	0.04	0.04	<0.06
Se		<0.05	<0.05	0.05	0.02	0.060	<0.05
Sn		<0.05	<0.5	<0.1	<0.1	<0.1	<0.1
Sr		<0.001	0.009	<0.006	0.009	0.004	<0.003
Ti		0.200	0.575	0.870	1.69	1.40	0.965
Tl		<0.005	0.008	0.008	0.006	0.006	0.008
V		<0.02	0.02	<0.04	<0.04	<0.04	<0.04
Zn		0.007	0.045	0.030	0.060	0.072	0.10

* MITRE SAMPLE NUMBER (OLD)

** MIDWEST RESEARCH INSTITUTE SAMPLE NUMBER

TABLE 50

ELEMENTAL CONTENT OF FLUE GAS PARTICULATE MATTER

MITRE TEST NO. 13: 35 MW, B FUEL, NO SOOT BLOWING,
NORM. EXCESS AIR, NORM. BURNER ANGLE

ELEMENT	ELEMENTAL CONTENT, WEIGHT PERCENT	
	LOCATION 2, AIR HEATER. NO. 209-2*	LOCATION 3, STACK, NO. 209-3*
Al	21.7	13.65
Ba	.08	<.04
Be	.0009	.0007
Ca	1.82	.62
Cd	.0009	.001
Co	.01	.011
Cr	.15	1.68
Cu	.01	.016
Fe	8.22	8.7
Ga	<.04	<.05
Ge		
Hg		
K	2.2	1.74
Mg	.89	.51
Mn	.06	.14
Mo	.003	<.002
Na	6.29	.88
Ni	.08	.63
Pb	.03	.02
Sb	<.04	<.06
Se	<.04	<.05
Sn	<.04	<.05
Sr	.001	<.0009
Ti	.59	.50
Tl	.006	.005
V	.04	.03
Zn	.08	.11
As		
Si		

* Midwest Research Institute's Sample Number

TABLE 51

ELEMENTAL CONTENT OF FLUE GAS PARTICULATE MATTER

MITRE Test No. 8: 100 MW, A Fuel, No Soot Blowing,
Maximum Excess Air, Normal Burner Angle

ELEMENT	ELEMENTAL CONTENT, WEIGHT PERCENT LOCATION 2, AIR HEATER, SAMPLE NO. 203-2*	LOCATION 3, STACK, SAMPLE NO. 203-3*
Al	30.9	31.8
Ba	0.4	0.6
Be	0.002	0.002
Ca	1.33	1.14
Cd	0.004	0.003
Co	0.030	0.020
Cr	0.050	0.220
Cu	0.030	0.040
Fe	14.8	11.7
Ga	0.07	<0.08
Ge	<0.09	0.00
Hg	0.0006	0.0004
K	2.54	2.42
Mg	0.770	0.670
Mn	0.090	0.080
Mo	<0.002	0.008
Na	83.6	48.6
Ni	0.05	0.09
Pb	0.110	0.160
Sb	0.170	0.130
Se	0.150	0.06
Sn	0.07	0.07
Sr	0.003	<0.0005
Ti	0.790	0.930
Tl	0.020	0.010
V	0.02	<0.02
Zn	0.060	0.080

* Midwest Research Institute's Sample Number

TABLE 52

ELEMENTAL CONTENT OF FLUE GAS PARTICULATE MATTER

MITRE Test No. 20: 50 MW, C Fuel, No Soot Blowing, Normal Excess Air, Normal Burner Angle

ELEMENT	ELEMENTAL CONTENT, WEIGHT PERCENT	
	LOCATION 2, AIR HEATER, SAMPLE NO. 213-2*	LOCATION 3, STACK, SAMPLE NO. 213-3*
Al	9.90	9.51
Ba	0.3	0.3
Be	0.0005	0.0008
Ca	2.62	1.10
Cd	<0.0005	0.0026
Co	0.012	0.011
Cr	0.175	0.926
Cu	0.012	0.019
Fe	5.60	6.47
Ga	0.06	<0.02
Ge	0.07	0.07
Hg	0.0000	0.0003
K	3.25	2.28
Mg	0.570	0.560
Mn	0.067	0.107
Mo	0.04	0.00
Na	0.581	0.911
Ni	0.135	0.515
Pb	0.014	0.017
Sb	0.06	0.04
Se	0.05	0.005
Sn	0.1	<0.1
Sr	0.006	0.003
Ti	1.40	1.37
Tl	0.005	0.004
V	0.04	<0.04
Zn	0.08	0.16

* Midwest Research Institute's Sample Number

TABLE 53

ELEMENTAL CONTENT OF FLUE GAS PARTICULATE MATTER

MITRE Test No. 19: 50 MW, A Fuel, No Soot Blowing,
Maximum Excess Air, Normal Burner Angle

ELEMENT	ELEMENTAL CONTENT, WEIGHT PERCENT LOCATION 2, AIR HEATER, SAMPLE NO. 217-2*	LOCATION 3, STACK, SAMPLE NO. 217-3*
Al	9.00	7.75
Ba	0.3	<0.2
Be	0.001	0.001
Ca	2.80	1.17
Cd	0.0022	0.001
Co	0.008	0.013
Cr	0.125	0.725
Cu	0.010	0.020
Fe	11.9	11.4
Ga	<0.02	<0.02
Ge	<0.07	<0.07
Hg	0.0001	0.0002
K	1.54	1.42
Mg	0.470	0.430
Mn	0.049	0.149
Mo	0.00	0.00
Na	0.570	0.738
Ni	0.120	0.493
Pb	0.007	0.005
Sb	0.04	0.04
Se	0.04	0.04
Sn	<0.1	<0.1
Sr	<0.003	<0.003
Ti	1.25	1.21
Tl	0.008	0.006
V	<0.04	<0.04
Zn	0.066	0.088

* Midwest Research Institute's Sample Number

TABLE 54

ELEMENTAL CONTENT OF FLUE GAS PARTICULATE MATTER

MITRE TEST NO. 17: 50 MW, A Fuel, Maximum Soot Blowing,
Normal Excess Air, Normal Burner Angle

	ELEMENTAL CONTENT, WEIGHT PERCENT	
ELEMENT	LOCATION 2, AIR HEATER, SAMPLE NO. 216-2*	LOCATION 3, STACK, SAMPLE NO. 216-3*
Al	8.40	5.90
Ba	<0.2	<0.2
Be	0.001	0.0008
Ca	2.57	0.660
Cd	<0.0005	<0.0012
Co	0.010	0.019
Cr	0.330	1.58
Cu	0.026	0.020
Fe	10.9	11.1
Ga	<0.02	<0.02
Ge	<0.07	<0.07
Hg	0.0001	0.0002
K	1.50	1.20
Mg	0.485	0.351
Mn	0.063	0.230
Mo	<0.04	0.00
Na	0.591	0.570
Ni	0.237	1.37
Pb	0.015	0.012
Sb	0.04	0.04
Se	0.05	0.05
Sn	<0.1	<0.1
Sr	0.005	<0.003
Ti	1.28	0.920
Tl	0.006	0.006
V	<0.04	<0.04
Zn	0.168	0.075

*Midwest Research Institute's Sample Number

TABLE 55

ELEMENTAL ANALYSES OF COAL FOR CAT-OX BASELINE PROGRAM*

(Concentrations in ppm)

Element and Isotope / MITRE Test No.	3	5	14	18	20	22
Ag^{110}	<.7	<.6	<.2	<.6	<.9	<.2
Al^{28}	8080	13,300	10,800	12,100	17,200	6170
As^{76}	<1.2	4.8	2.44	<5	7.00	1.6
Au^{198}	.10	0.7	.06	0.15	.003	.02
Ba^{139}	34	48	45	53	92	29
Br^{80}	20	3.9	3.4	32.5	7	4.4
Br^{82}	3	22	9.0	19	20	16
Ca^{49}	3640	5640	3290	<50	7740	1910
Cd^{115}	<110	<110	<200	<90	<300	30
Ce^{141}	8.83	16.2	10.6	13.0	21.1	8.97
Cl^{38}	1220	2760	1250	1450	2820	2350
Co^{58}	<30	<80	<60	<70	<90	<30
Co^{60}	3.07	5.22	3.84	4.40	5.98	4.02
Cr^{51}	18.0	21.4	19.3	19.4	24.2	12.2
Cs^{134}	1.56	2.58	2.03	2.35	3.32	1.13
Cu^{64}	29	<20	<20	<20	<30	<20
Cu^{66}	<20	<40	<50	<20	<60	<30
Dy^{165}	0.58	0.76	0.67	0.77	1.2	0.42
Eu^{152m1}	0.2	0.32	.30	0.31	0.56	.18
Eu^{152m8}	.13	.26	.19	0.20	0.32	.12
Fe^{59}	13,700	9500	11,600	10,900	8970	4550
Ga^{72}	<2	4.0	5.5	4.2	7.2	2.9
Gd^{159}	<60	<40	<4	<30	<70	<20
Ge^{75}	<4	<120	<150	<40	<70	<150
Hf^{181}	.50	.81	.60	.65	1.05	.42
Hg^{203}	<.5	<.6	.16	1.91	<.7	<.3
I^{128}	<1	<.05	<2	1.8	<.2	.65
In^{116}	<0.03	<0.02	0.029	.073	<0.05	<0.01
Ir^{192}	1.9	2.2	1.6	6.7	5.3	1.8

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*Analyses performed by NASA Plumbrook Laboratory

TABLE 55 (CONTINUED)

ELEMENTAL ANALYSES OF COAL FOR CAT-OX BASELINE PROGRAM*

(Concentrations in ppm)

Element and Isotope / MITRE Test No.	3	5	14	18	20	22
K^{42}	2464	3932	3429	3748	7130	1690
La^{140}	5.7	7.2	7.3	26	17.2	5.4
Lu^{77}	.36	.42	.35	.32	.58	.22
Mg^{27}	<850	<1200	586	<4000	<450	<600
Mn^{56}	53	62	38	49	95	25
Mo^{99}	<700	<260	<300	<350	<600	<200
Mo^{101}	<10	<100	<70	<40	<50	<10
Na^{24}	882	1070	757	833	1250	487
Nd^{14}	<2	<2	<7	<5	<7	<3
Ni^{65}	<50	<400	<600	<300	<1000	<200
Pt^{197}	<170	<160	<200	<230	<300	<100
Rb^{86}	12.3	20.7	16.8	21.4	25.6	7.98
Rb^{88}	<550	<200	<120	<300	<300	<400
Re^{186}	<0.2	<0.2	<.4	<.3	<.3	<.3
Rh^{104}	<0.09	<0.04	<.06	<.2	<0.03	<.06
S^{37}	<90,000	<53,000	<9060	<7000	**	<30,000
Sc^{46}	2.67	3.84	3.17	3.42	4.56	3.02
Sb^{124}	0.84	1.12	.62	.93	1.39	.86
Se^{75}	3.12	2.99	2.86	3.19	4.15	1.77
Sm^{153}	.82	1.2	1.1	1.2	2.23	0.81
Sr^{87}	<30	36	<40	<20	56	<20
Sn^{117}	<40	74.2	50	66	76.5	34
Sn^{123}	<50	<40	<15	<20	<50	<2
Sn^{125}	<200	<40	<10	<70	<500	<150
Ta^{182}	.12	.27	.18	.25	.35	.17
Tb^{160}	.018	.027	.022	.025	.036	.015
Th^{232}	2.16	3.23	2.84	2.84	4.19	1.73
Ti^{51}	912	608	908	980	1680	529
U^{23q}	0.96	0.82	0.82	1.14	1.5	0.65
V^{52}	23	26	23	27	34	15
W^{187}	<0.3	<0.4	<2	<2	<4	<2
Yb^{175}	1.88	4.06	.46	1.83	3.68	.91
Zn^{65}	<3000	220	118	148	264	<400
Zr^{95}	<50	<50	<50	<40	<50	<30

*Analyses performed by NASA Plumbrook Laboratory

**Data missing

Results of Analysis of Bound SO_2, SO_3, and Polynuclear Aromatic Compounds

Bound constituents were determined by chemical analysis by the Midwest Research Institute for fly ash samples collected at location 2 and location 3. The results of these analyses are provided in Tables 56 and 57.

As noted in Table 56, the bound SO_2 concentration (measured as sulfates) ranges from .15 microgram to .88 microgram per milligram of particulate. For the two tests representing these extremes (test 22 and test 8), the measured particulate emission rates at location 3 were respectively 1200 lbs/hour and 2166 lbs/hour. The measured gaseous SO_2 mass flow rates at location 3 for these tests were 1452 lbs/hour and 3810 lbs/hour, respectively. Multiplying the bound SO_2 concentration ranges by the particulate emission rates provides a mass emission rate of bound SO_2 in terms of lbs/hour. Comparison of the mass rate against the gaseous mass flow rates shows that the amount of bound SO_2 released to the atmosphere is on the order of 10^{-10} of the mass released in gaseous form.

Measurement of gaseous SO_3 mass flow rates was not successfully accomplished in the baseline test due to problems with sample handling. For this reason, no comparison can be made between the adsorbed SO_3 (measured as sulfites) and the gaseous SO_3.

Table 57 is self-explanatory and provides the polynuclear aromatic hydrocarbons bound to the surface of the particulates. Highest confidence should be placed on those tests with the highest % of recovery (i.e., the percentage of the original mass which can be accounted for as extracted organic material and particulate fly ash). As noted in Table 57, the organic materials found were Benzo(α)Pyrene, and possibly Anthanthrene, Chrysene, and 1,2-Benzanthrecene.

The chemical state of the sulfur adsorbed on the surface of fly ash samples was also determined by the Oak Ridge National Laboratory. The results of these analyses are provided in the Laboratory's final report which appears as Appendix D. Three techniques were used by the Oak Ridge National Laboratory to examine each of ten fly ash samples: photoelectron

TABLE 56

DETERMINATION OF BOUND SO_2 AND SO_3 BY CHEMICAL ANALYSIS

TEST NO.	LOAD FACTOR	FUEL TYPE	SOOT BLOWER	EXCESS AIR	BURNER ANGLE	SO_2 MICROGRAM/ MILLIGRAM PARTICULATE	SO_3 MICROGRAM/ MILLIGRAM PARTICULATE	LOCATION
8	100	A	NONE	MAX.	NORM.	.77	5.77	2
8	100	A	NONE	MAX.	NORM.	.88	7.65	3
1	75	B	NONE	NORM.	NORM.	.30	9.34	2
1	75	B	NONE	NORM.	NORM.	.39	24.10	3
5	75	C	NONE	NORM.	NORM.	.16	0.67	2
5	75	C	NONE	NORM.	NORM.	.16	15.84	3
17	50	A	MAX.	NORM.	NORM.	.37	13.69	2
17	50	A	MAX.	NORM.	NORM.	.35	3.77	3
22	75	D	NONE	NORM.	NORM.	.4	2.25	2
22	75	D	NONE	NORM.	NORM.	.15	1.63	3

TABLE 57

DETERMINATION OF POLYNUCLEAR AROMATIC COMPOUNDS BOUND TO THE SURFACE OF FLUE GAS PARTICULATES

DATE:	11/10/71	11/15/71	11/22/71	12/2/71	12/9/71
MITRE TEST NO.:	8	1	5	17*	22
TEST CONDITIONS					
Load Factor:	100	75	75	50	75
Fuel Type:	A	B	C	A	D
Soot Blower:	None	None	None	Maximum	None
Excess Air:	Maximum	Normal	Normal	Normal	Normal
Burner Angle:	Normal	Normal	Normal	Normal	
TOTAL					
RECOVERY %					
Location 2	100.0	No Peaks	91.7	25.0	37.5
Location 3	100.0	17.7	100.0	31.2	No peaks
BENZO(α)PYRENE (μg)					
Location 2			21.80	200.00	74.67
Location 3		259.89	126.00	185.90	
CONCENTRATION (μg/mg)					
Location 2			0.17	0.72	1.16
Location 3		3.00	0.87	0.83	
OTHER POSSIBLE COMPONENTS					
Location 2	Anthanthrene				
Location 3	Anthanthrene			Chrysene; 1,2-Benzanthrecene	

* Two samples were collected at each location during this test. Both samples were combined for the determination of surface adsorbed polynuclear aromatic compounds.

spectroscopy (ESCA); surface area determination by the BET method; total sulfur determination by combustion analysis. One of the specimens was also examined by infrared spectroscopy.

The following are firm conclusions that can be made:

1. The photoelectron spectroscopy results show that the oxidation state of sulfur on the surfaces of all ten samples is +6.
2. The high intensities of photoelectron peaks arising from sulfur indicate that in all samples most of the sulfur is segregated at the surface rather than distributed homogeneously in the solid phase.
3. Surface area measurements and total sulfur determinations show that the degree of surface coverage by sulfate salts varies 5-40 monolayers.
4. The spectrum of the sample studied by infrared spectroscopy shows that sulfur is present on the surface as sulfate rather than as adsorbed SO_3. Apparent discrepencies between this conclusion and the findings of MRI can be explained by the greater sensitivity of the wet chemical methods used by MRI as compared with infrared spectroscopy.

The following observations were also made; however, it was felt that more study would be needed before they could be stated as firm conclusions:

1. Binding energies of S_2 p electrons, determined by photoelectron spectroscopy, closely match those for sulfates of polyvalent cations such as Fe^{+2}, Fe^{+3}, and Ca^{+2}. The sulfur may be present on the fly ash surfaces as calcium or iron sulfate.
2. Photoelectron peaks for silicon were broadened. This suggests the presence of more than one chemical state of silicon. The +4 oxidation state, indicating silicates of SiO_2, is definitely present, but lower oxidation states may be present also. Different glass phases containing silicon may also have caused the peak broadening. More study is necessary to be sure that the broadening of the silicon peaks is not due to interference by other elements.

SECTION VI

APPENDICES

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APPENDIX A

RESULTS OF PRELIMINARY MEASUREMENT TEST

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TABLE A1

VELOCITY TRAVERSE AT ECONOMIZER (LOCATION 1)

TEST: 9/28 - 9/29
100 MW LOAD
115% EXCESS AIR
COAL TYPE A
NO SOOT BLOWING

PERCENT O_2 BY VOLUME (ORSAT)	3.3%
PERCENT CO_2 BY VOLUME (ORSAT)	15.7%
PERCENT MOISTURE	5.6%

PORT	POINT	MEASURED VELOCITY (FEET/MINUTE)
1	1	1378
	2	970
	3	1214
	4	1081
2	1	1643
	2	1612
	3	1057
	4	1262

TABLE A2

VELOCITY TRAVERSE AT ECONOMIZER (LOCATION 1)

TEST: 9/30
100 MW LOAD
125% EXCESS AIR
COAL TYPE A
NO SOOT BLOWING

PERCENT O_2 BY VOLUME (ORSAT)	4.3%
PERCENT CO_2 BY VOLUME (ORSAT)	14.9%
PERCENT MOISTURE	6.1%

PORT	POINT	MEASURED VELOCITY (FEET/MINUTE)
1	1	1150
	2	1116
	3	1537
	4	1409
2	1	1522
	2	888
	3	1537
	4	1370
3	1	1597
	2	851
	3	1052
	4	1323
4	1	1465
	2	1098
	3	2052
	4	1720
5	1	1185
	2	1051
	3	1154
	4	927
6	1	2069
	2	916
	3	1076
	4	918
7	1	689
	2	873
	3	-
	4	-

TABLE A3

VELOCITY TRAVERSE AT ECONOMIZER (LOCATION 1)

TEST: 10/1
100 MW LOAD
125% EXCESS AIR
COAL TYPE A
NO SOOT BLOWING

PERCENT O_2 BY VOLUME (ORSAT)	8.0%
PERCENT CO_2 BY VOLUME (ORSAT)	12.0%
PERCENT MOISTURE	8.7%

PORT	POINT	MEASURED VELOCITY (FEET/MINUTE)
2	1	1740
	2	1001
	3	1087
	4	1582
4	1	1427
	2	1208
	3	1415
	4	1457
6	1	1007
	2	1085
	3	1100
	4	1177

TABLE A4

VELOCITY TRAVERSE AT ECONOMIZER (LOCATION 1)

TEST: 10/5
100 MW LOAD
125% EXCESS AIR
COAL TYPE A
SOOT BLOWING OVER PERIOD OF TEST

PERCENT O_2 BY VOLUME (ORSAT) 4.2%
PERCENT CO_2 BY VOLUME (ORSAT) 14.7%
PERCENT MOISTURE 6.25%

PORT	POINT	MEASURED VELOCITY (FEET/MINUTE)
1	1	855
	2	1020
	3	1025
	4	850
2	1	1591
	2	885
	3	795
	4	1372
3	1	1470
	2	840
	3	1090
	4	1040
4	1	1155
	2	960
	3	930
	4	890
5	1	1255
	2	1035
	3	1010
	4	995
6	1	1480
	2	940
	3	740
	4	978
7	1	1270
	2	940
	3	-
	4	-

TABLE A5

VELOCITY TRAVERSE AT ECONOMIZER (LOCATION 1)

TEST: 10/6
100 MW LOAD
125% EXCESS AIR
COAL TYPE A
NO SOOT BLOWING

PERCENT O_2 BY VOLUME (ORSAT)	4.2%
PERCENT CO_2 BY VOLUME (ORSAT)	14.4%
PERCENT MOISTURE	4.8%

PORT	POINT	MEASURED VELOCITY (FEET/MINUTE)
1	1	836
	2	902
	3	864
	4	1389
2	1	1514
	2	770
	3	942
	4	1409
3	1	1644
	2	857
	3	983
	4	1156
4	1	1370
	2	1106
	3	1131
	4	1563
5	1	1491
	2	723
	3	975
	4	1270
6	1	1531
	2	695
	3	940
	4	1480
7	1	1223
	2	858
	3	-
	4	-

TABLE A6

VELOCITY TRAVERSE AT ECONOMIZER (LOCATION 1)

TEST: 10/8
35 MW LOAD
145% EXCESS AIR
COAL TYPE A
NO SOOT BLOWING

PERCENT O_2 BY VOLUME (ORSAT)	5.6%
PERCENT CO_2 BY VOLUME (ORSAT)	13.2%
PERCENT MOISTURE	2.3%

PORT	POINT	MEASURED VELOCITY (FEET/MINUTE)
1	1	404
	2	397
	3	394
	4	584
2	1	576
	2	362
	3	362
	4	399
3	1	598
	2	363
	3	363
	4	567
4	1	522
	2	491
	3	326
	4	494
5	1	437
	2	399
	3	516
	4	633
6	1	621
	2	399
	3	399
	4	695
7	1	614
	2	323
	3	-
	4	-

TABLE A7

COAL ANALYSES FOR PRELIMINARY TEST RUNS

DATE	TEST CONDITIONS	MOISTURE	ASH	SULFUR	BTU'S AS RECEIVED	BTU DRY	BTU, MOISTURE AND ASH FREE
10/28 10/29	100 MW LOAD 115% EXCESS AIR COAL TYPE A NO SOOT BLOWING	11.40	10.02	3.01	11,041	12,462	14,051
9/30	100 MW LOAD 125% EXCESS AIR COAL TYPE A NO SOOT BLOWING	11.95	9.48	2.96	11,032	12,529	14,040
10/1	100 MW LOAD 125% EXCESS AIR COAL TYPE A NO SOOT BLOWING	11.75	10.13	2.87	11,027	12,495	14,115
10/5	100 MW LOAD 125% EXCESS AIR COAL TYPE A SOOT BLOWING OVER PERIOD OF TEST	11.15	10.67	2.91	11,072	12,462	14,163
10/6	100 MW LOAD 125% EXCESS AIR COAL TYPE A NO SOOT BLOWING	12.98	10.42	2.87	10,797	12,407	14,094
10/8	35 MW LOAD 145% EXCESS AIR COAL TYPE A NO SOOT BLOWING	13.02	10.72	2.95	10,780	12,394	14,137

```
                                        TABLE  A8
                             GRAIN LOADING AT AIR HEATER (LOCATION 2)
                         TEST       DATE
                         101        92871

AIR TEMP.  ATM. PRESS.  STACK VAC.  CONDENSATE PARTICULATE  STACK AREA  INIT. VOL.     PO2        PCO2
  90.00        29.420      8.5000    97.10000      7.27270   173.70700   855.8300     .0910      .0970

PORT     TIME   METER VOL   DELTA P  TEMP. IN  TEMP. OUT  TRAIN VAC.  STK. TEMP.  HOX TEMP.  PROBE DIA.   VELOCITY

1  1     2.00   857.0100     .083     92.000    92.000      6.5000     350.000     -80.000      .3750     1241.91
1  2     2.00   858.3100     .090     94.000    92.000      7.1000     385.000     -67.000      .3750     1320.86
1  3     2.00   859.3500     .065     95.000    92.000      5.0000     385.000     -77.000      .3750     1122.52
1  4     2.00   860.2000     .033     98.000    92.000      4.0000     385.000     -75.000      .3750      799.82
1  5     2.00   861.2600     .093    100.000    92.000      6.0000     385.000     -75.000      .3750     1342.70
1  6     2.00   862.3800     .080    100.000    95.000      6.5000     385.000     -80.000      .3750     1245.32
1  7     2.00   863.6000     .100    102.000    94.000      8.0000     385.000     -70.000      .3750     1392.31
1  8     2.00   864.9700     .100    106.000    96.000      8.0000     385.000     -65.000      .3750     1392.31
1  9     2.00   866.1300     .100    109.000    96.000      8.0000     385.000     -75.000      .3750     1392.31
1 10     2.00   867.4100     .100    112.000    96.000      8.0000     385.000     -76.000      .3750     1392.31
1 11     2.00   868.6000     .086     96.000    96.000      7.0000     405.000     -70.000      .3750     1306.37
1 12     2.00   869.8300     .094    100.000    96.000      8.0000     405.000     -65.000      .3750     1365.78
1 13     2.00   871.0300     .085    100.000    95.000      8.0000     405.000     -65.000      .3750     1298.75
1 14     2.00   872.1400     .073    104.000    96.000      7.0000     400.000     -65.000      .3750     1200.10
1 15     2.00   873.3100     .090    106.000    96.000      8.0000     415.000     -65.000      .3750     1344.10
1 16     2.00   874.4700     .084    100.000    96.000      7.0000     410.000     -75.000      .3750     1294.81
1 17     2.00   875.7200     .100    103.000    98.000      9.0000     410.000     -70.000      .3750     1412.76
1 18     2.00   877.0000     .100    107.000    98.000      9.0000     420.000     -70.000      .3750     1420.95
1 19     2.00   878.2000     .093    110.000    98.000      8.0000     410.000     -75.000      .3750     1362.41
1 20     2.00   879.3800     .094    113.000    98.000      8.0000     410.000     -75.000      .3750     1369.72
2  1     2.00   880.3300     .058    100.000   100.000      5.0000     410.000     -80.000      .3750     1075.92
2  2     2.00   881.4000     .083    102.000   100.000      7.0000     410.000     -75.000      .3750     1287.08
2  3     2.00   882.5000     .075    106.000   100.000      7.0000     415.000     -65.000      .3750     1226.99
2  4     2.00   883.5800     .070    108.000   100.000      7.0000     410.000     -70.000      .3750     1182.00
2  5     2.00   884.7100     .092    112.000   100.000      8.0000     420.000     -65.000      .3750     1362.83
2  6     2.00   885.8400     .076    110.000   102.000      8.0000     420.000     -80.000      .3750     1254.96
2  7     2.00   886.9300     .075    110.000   104.000      8.0000     420.000     -80.000      .3750     1230.49
2  8     2.00   887.9500     .062    110.000   104.000      7.0000     420.000     -75.000      .3750     1118.78
2  9     2.00   888.9300     .060    112.000   104.000      7.0000     430.000     -80.000      .3750     1106.42
2 10     2.00   889.8500     .052    113.000   106.000      7.0000     430.000     -80.000      .3750     1030.40
2 11     2.00   891.0000     .150    106.000   106.000      9.0000     418.000     -75.000      .3750     1738.20
2 12     2.00   892.1400     .080    108.000   106.000      9.0000     418.000     -70.000      .3750     1269.40
2 13     2.00   893.2500     .090    110.000   106.000      9.0000     418.000     -70.000      .3750     1346.41
2 14     2.00   894.3600     .080    112.000   106.000      9.0000     418.000     -70.000      .3750     1269.40
2 15     2.00   895.5500     .093    116.000   106.000     10.0000     418.000     -70.000      .3750     1365.66
2 16     2.00   896.6800     .078    120.000   106.000     10.0000     418.000     -75.000      .3750     1253.44
2 17     2.00   897.9200     .115    122.000   108.000     12.0000     418.000     -75.000      .3750     1521.96
2 18     2.00   899.2400     .115    126.000   108.000     13.0000     418.000     -75.000      .3750     1521.96
2 19     2.00   900.6000     .110    130.000   110.000     13.0000     418.000     -80.000      .3750     1408.51
2 20     2.00   901.8000     .082    132.000   110.000     10.0000     418.000     -80.000      .3750     1285.17

P MOIST.  AVE. VEL.  FLOWRATE   ISO. RATIO  EMIS. RATE  PART. LOAD  STD. LOAD
  .0976   1298.9734  225633.8      1.0039   2708.6811      1.4006      2.3818        TEST:  9/28 - 9/29
                                                                                           100 MW LOAD
                                 UNDER 5 MICRONS   5 TO 80 MICRONS   OVER 80 MICRONS       115% EXCESS AIR
ANISO CORRECTION FACTOR              1.0000            1.0019            1.0039            COAL TYPE A
EMISSION RATE                     2708.6811         2713.8870         2719.1129            NO SOOT BLOWING
PART. LOAD                           1.4006            1.4032            1.4059
STD. LOAD                            2.3818            2.3864            2.3910
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                                                  TABLE  A9
                                     GRAIN LOADING AT AIR HEATER (LOCATION 2)
                                  TEST       DATE
                                  102        93071

AIR TEMP.  ATM. PRESS.  STACK VAC.  CONDENSATE PARTICULATE  STACK AREA  INIT. VOL.     PO2       PCO2
   90.00        29.420      0.1000    62.20000      3.22910  173.70700    880.1500     .0900     .0980

PORT     TIME   METER VOL  DELTA P  TEMP. IN  TEMP. OUT  TRAIN VAC.  STK. TEMP.  F X TEMP.  PROBE DIA.   VELOCITY

2  1     2.00   881.0000     .145   100.000    100.000      6.0000     200.000    -70.000       .2500     1481.13
2  2     2.00   881.9500     .065   100.000    100.000      4.0000     300.000    -80.000       .2500     1064.14
2  3     2.00   882.8700     .080   102.000    100.000      4.0000     360.000    -80.000       .2500     1226.28
2  4     2.00   883.7900     .075   106.000    100.000      5.0000     390.000    -75.000       .2500     1208.86
2  5     2.00   884.7500     .087   108.000    100.000      5.0000     405.000    -75.000       .2500     1313.42
2  6     2.00   885.6900     .080   108.000    100.000      5.0000     405.000    -90.000       .2500     1259.48
2  7     2.00   886.6900     .095   110.000    100.000      5.0000     410.000    -80.000       .2500     1376.44
2  8     2.00   887.6600     .085   112.000    100.000      5.0000     405.000    -75.000       .2500     1298.24
2  9     2.00   888.6100     .085   114.000    102.000      5.0000     400.000    -80.000       .2500     1294.48
2 10     2.00   889.5500     .080   116.000    104.000      5.0000     400.000    -80.000       .2500     1255.83
2 11     2.00   890.3700     .058   104.000    104.000      5.0000     410.000    -90.000       .2500     1075.50
2 12     2.00   891.2900     .086   106.000    106.000      5.0000     410.000    -85.000       .2500     1309.62
2 13     2.00   892.2300     .086   108.000    106.000      5.0000     410.000    -80.000       .2500     1309.62
2 14     2.00   893.1300     .073   110.000    106.000      5.0000     410.000    -80.000       .2500     1206.58
2 15     2.00   894.1000     .092   112.000    106.000      6.0000     420.000    -80.000       .2500     1362.30
2 16     2.00   895.0400     .087   110.000    106.000      6.0000     420.000    -85.000       .2500     1324.76
2 17     2.00   895.9800     .080   110.000    106.000      6.0000     425.000    -80.000       .2500     1273.95
2 18     2.00   896.8800     .077   114.000    106.000      6.0000     430.000    -80.000       .2500     1253.36
2 19     2.00   897.7900     .077   116.000    107.000      6.0000     430.000    -80.000       .2500     1253.36
2 20     2.00   898.6700     .060   118.000    108.000      6.0000     450.000    -80.000       .2500     1118.75
1  1     2.00   899.2900     .081    98.000     99.000      3.0000     415.000    -90.000       .2500     1274.63
1  2     2.00   899.7300     .094    98.000    100.000      3.0000     415.000    -90.000       .2500     1373.11
1  3     2.00   900.2800     .085   100.000    100.000      3.0000     415.000    -90.000       .2500     1305.72
1  4     2.00   900.8700     .070   100.000    100.000      3.0000     405.000    -85.000       .2500     1178.13
1  5     2.00   901.3100     .085   102.000    100.000      3.0000     425.000    -85.000       .2500     1313.16
1  6     2.00   901.8300     .078   103.000    100.000      3.5000     425.000    -85.000       .2500     1257.93
1  7     2.00   902.4900     .095   104.000    100.000      4.0000     425.000    -95.000       .2500     1388.26
1  8     2.00   903.0700     .089   105.000    101.000      4.0000     426.000    -90.000       .2500     1344.46
1  9     2.00   903.5100     .087   106.000    102.000      4.0000     430.000    -90.000       .2500     1332.27
1 10     2.00   904.0500     .084   107.000    102.000      4.0000     453.000    -90.000       .2500     1325.90
1 11     2.00   904.6100     .080   100.000    100.000      3.0000     395.000    -90.000       .2500     1252.17
1 12     2.00   905.1400     .084   100.000    102.000      3.0000     395.000    -85.000       .2500     1283.10
1 13     2.00   905.7400     .065   101.000    102.000      3.0000     400.000    -80.000       .2500     1131.99
1 14     2.00   906.0800     .030   101.000    102.000      2.0000     390.000    -85.000       .2500      764.55
1 15     2.00   906.5900     .085   103.000    102.000      4.0000     414.000    -90.000       .2500     1304.97
1 16     2.00   907.0900     .069   104.000    102.000      4.0000     414.000    -90.000       .2500     1175.75
1 17     2.00   907.5300     .095   105.000    102.000      4.0000     420.000    -90.000       .2500     1384.33
1 18     2.00   908.1000     .090   106.000    102.000      4.0000     420.000    -90.000       .2500     1347.41
1 19     2.00   908.7500     .090   107.000    103.000      4.0000     420.000    -90.000       .2500     1347.41
1 20     2.00   909.2200     .090   108.000    103.000      4.0000     429.000    -90.000       .2500     1354.28

P MOIST.  AVE. VEL.   FLOWRATE   ISO. RATIO   EMIS. RATE   PART. LOAD   STD. LOAD
  .0991   1267.6408   220198.1       1.4563    1865.3039        .9883      1.6758           TEST:  9/30
                                                                                                   100 MW LOAD
                                  UNDER 5 MICRONS   5 TO 80 MICRONS   OVER 80 MICRONS              125% EXCESS AIR
ANISO CORRECTION FACTOR                  1.0000            1.1858            1.4563                COAL TYPE A
EMISSION RATE                         1865.3039         2211.8061         2716.4116                NO SOOT BLOWING
PART. LOAD                                .9883            1.1719            1.4392
STD. LOAD                                1.6758            1.9871            2.4404
```

TABLE A10

GRAIN LOADING AT AIR HEATER (LOCATION 2)

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                                        TEST      DATE
                                        103       100171

AIR TEMP.  ATM. PRESS.  STACK VAC.  CONDENSATE PARTICULATE  STACK AREA  INIT. VOL.     PO2      PCO2
  90.00       29.420      7.9000     42.10000     3.25640    173.70700   923.3700     .0800    .1200

PORT    TIME   METER VOL  DELTA P  TEMP. IN  TEMP. OUT  TRAIN VAC.  STK. TEMP.  BOX TEMP.  PROBE DIA.  VELOCITY

3  1    2.00   923.9500    .066     96.000    96.000     2.2000     224.000    -80.000     .2500     1010.72
3  2    2.00   924.5300    .095     98.000    96.000     2.2000     350.000    -85.000     .2500     1319.57
3  3    2.00   925.1800    .089     98.000    96.000     2.5000     376.000    -80.000     .2500     1297.56
3  4    2.00   925.6800    .072     99.000    97.000     2.5000     390.000    -80.000     .2500     1176.80
3  5    2.00   926.1200    .090    100.000    97.000     2.5000     395.000    -85.000     .2500     1319.57
3  6    2.00   926.6100    .074    102.000    98.000     2.0000     400.000    -85.000     .2500     1200.03
3  7    2.00   927.2600    .094    103.000    98.000     3.0000     410.000    -85.000     .2500     1360.36
3  8    2.00   927.8400    .096    104.000    98.000     3.0000     405.000    -85.000     .2500     1370.79
3  9    2.00   928.3900    .095    106.000    98.000     3.0000     415.000    -85.000     .2500     1371.50
3 10    2.00   928.8500    .090    107.000   100.000     3.0000     415.000    -85.000     .2500     1334.92
3 11    2.00   929.4900    .085     99.000    99.000     2.5000     415.000    -85.000     .2500     1297.31
3 12    2.00   930.0200    .085    100.000   101.000     3.0000     403.000    -80.000     .2500     1288.38
3 13    2.00   930.5600    .085    101.000   101.000     3.0000     410.000    -80.000     .2500     1293.59
3 14    2.00   931.0500    .065    103.000   102.000     2.3000     410.000    -80.000     .2500     1131.21
3 15    2.00   931.5500    .085    104.000   101.000     3.0000     413.000    -80.000     .2500     1295.82
3 16    2.00   932.0800    .075    105.000   102.000     3.0000     421.000    -80.000     .2500     1222.78
3 17    2.00   932.5700    .084    106.000   102.000     2.0000     421.000    -80.000     .2500     1294.07
3 18    2.00   933.0000    .084    108.000   102.000     2.0000     425.000    -80.000     .2500     1297.00
3 19    2.00   933.6000    .081    110.000   103.000     2.0000     430.000    -80.000     .2500     1277.22
3 20    2.00   934.1500    .089    112.000   104.000     3.0000     445.000    -80.000     .2500     1350.04
4  1    2.00   934.6700    .084     96.000    96.000     2.5000     404.000   -100.000     .2500     1281.52
4  2    2.00   935.1900    .084     96.000    96.000     3.0000     394.000    -90.000     .2500     1274.08
4  3    2.00   935.6100    .079     97.000    96.000     2.5000     400.000    -90.000     .2500     1239.91
4  4    2.00   936.1700    .060     98.000    97.000     2.0000     400.000    -85.000     .2500     1080.57
4  5    2.00   936.6700    .079    100.000    97.000     3.0000     415.000    -85.000     .2500     1250.68
4  6    2.00   937.1800    .078    100.000    97.000     3.0000     415.000    -85.000     .2500     1242.74
4  7    2.00   937.6000    .081    102.000    97.000     3.0000     420.000    -85.000     .2500     1270.03
4  8    2.00   938.1900    .075    103.000    98.000     3.0000     420.000    -85.000     .2500     1222.08
4  9    2.00   938.6900    .075    104.000    98.000     3.0000     425.000    -85.000     .2500     1225.55
4 10    2.00   939.1000    .079    105.000    98.000     3.0000     435.000    -85.000     .2500     1264.89
4 11    2.00   939.6600    .065     96.000    96.000     2.0000     363.000    -90.000     .2500     1100.23
4 12    2.00   940.1700    .090     96.000    97.000     3.0000     378.000    -90.000     .2500     1306.39
4 13    2.00   940.6300    .094     97.000    97.000     3.0000     385.000    -85.000     .2500     1340.67
4 14    2.00   941.1400    .074     98.000    97.000     3.0000     385.000    -85.000     .2500     1189.52
4 15    2.00   941.7800    .087    100.000    97.000     3.0000     410.000    -80.000     .2500     1308.72
4 16    2.00   942.2400    .089    101.000    97.000     3.0000     400.000    -80.000     .2500     1316.05
4 17    2.00   942.8100    .099    102.000    97.000     3.0000     410.000    -80.000     .2500     1396.07
4 18    2.00   943.3500    .084    103.000    97.000     3.0000     400.000    -80.000     .2500     1278.55
4 19    2.00   943.8200    .057    103.000    97.000     2.0000     404.000    -85.000     .2500     1055.66
4 20    2.00   944.3500    .090    104.000    97.000     3.0000     415.000    -85.000     .2500     1334.92

P MOIST.  AVE. VEL.   FLOWRATE   ISO. RATIO   EMIS. RATE   PART. LOAD   STD. LOAD
  .0927   1262.2019   219253.3      1.0537    2599.8540       1.3834      2.3358

                              UNDER 5 MICRONS   5 TO 80 MICRONS   OVER 80 MICRONS
ANISO CORRECTION FACTOR            1.0000            1.0261            1.0537
EMISSION RATE                   2599.8540         2667.7926         2739.3771
PART. LOAD                         1.3834            1.4196            1.4576
STD. LOAD                          2.3358            2.3968            2.4611
```

TEST: 10/1
100 MW LOAD
125% EXCESS AIR
COAL TYPE A
NO SOOT BLOWING

TABLE A11

GRAIN LOADING AT AIR HEATER (LOCATION 2)

TEST	DATE
104	100571

AIR TEMP.	ATM. PRESS.	STACK VAC.	CONDENSATE	PARTICULATE	STACK AREA	INIT. VOL.	PO2	PCO2
90.00	29.420	7.8000	33.20000	4.08360	173.70760	962.2200	.0740	.1140

PORT		TIME	METER VOL	DELTA P	TEMP. IN	TEMP. OUT	TRAIN VAC.	STK. TEMP.	BOX TEMP.	PROBE DIA.	VELOCITY
4	1	2.00	962.7100	.080	82.000	82.000	3.0000	365.000	-78.000	.2500	1234.22
4	2	2.00	963.2200	.070	82.000	82.000	3.0000	370.000	-72.000	.2500	1144.22
4	3	2.00	963.7200	.075	84.000	82.000	3.0000	380.000	-72.000	.2500	1191.49
4	4	2.00	964.1400	.050	85.000	83.000	2.0000	382.000	-75.000	.2500	974.01
4	5	2.00	964.6200	.074	87.000	83.000	3.0000	395.000	-75.000	.2500	1194.04
4	6	2.00	965.1250	.075	88.000	84.000	3.0000	405.000	-75.000	.2500	1209.09
4	7	2.00	965.6250	.075	89.000	84.000	3.0000	395.000	-75.000	.2500	1202.0[illegible]
4	8	2.00	966.1100	.069	90.000	85.000	3.0000	381.000	-75.000	.2500	1143.52
4	9	2.00	966.6100	.070	91.000	85.000	3.0000	398.000	-80.000	.2500	1163.36
4	10	2.00	967.0800	.067	92.000	86.000	3.0000	410.000	-80.000	.2500	1146.09
4	11	2.00	967.6800	.110	87.000	87.000	4.0000	277.000	-85.000	.2500	1351.61
4	12	2.00	968.5500	.088	88.000	87.000	4.0000	337.000	-85.000	.2500	1257.16
4	13	2.00	968.7800	.080	89.000	88.000	4.0000	355.000	-85.000	.2500	1212.12
4	14	2.00	969.2500	.060	90.000	88.000	3.0000	355.000	-85.000	.2500	1049.72
4	15	2.00	969.7450	.075	91.000	88.000	4.0000	371.000	-85.000	.2500	1195.09
4	16	2.00	970.2400	.068	92.000	88.000	4.0000	373.000	-85.000	.2500	1129.79
4	17	2.00	970.7450	.075	93.000	89.000	4.0000	391.000	-85.000	.2500	1199.27
4	18	2.00	971.2550	.075	94.000	89.000	4.0000	378.000	-85.000	.2500	1190.07
4	19	2.00	971.7650	.072	95.000	90.000	3.0000	382.000	-85.000	.2500	1166.81
4	20	2.00	972.2520	.067	96.000	90.000	3.0000	396.000	-90.000	.2500	1136.83
3	1	2.00	972.7950	.073	86.000	87.000	3.0000	221.000	-85.000	.2500	1058.41
3	2	2.00	973.3400	.085	87.000	87.000	3.0000	389.000	-80.000	.2500	1275.22
3	3	2.00	973.8500	.079	88.000	87.000	3.0000	353.000	-80.000	.2500	1203.04
3	4	2.00	974.3200	.057	89.000	87.000	3.0000	362.000	-80.000	.2500	1027.53
3	5	2.00	974.8250	.078	90.000	88.000	3.0000	375.000	-80.000	.2500	1211.47
3	6	2.00	975.3240	.068	91.000	88.000	3.0000	371.000	-80.000	.2500	1126.43
3	7	2.00	975.8400	.083	92.000	88.000	3.0000	376.000	-80.000	.2500	1250.44
3	8	2.00	976.3820	.086	93.000	89.000	3.0000	370.000	-80.000	.2500	1266.26
3	9	2.00	976.9400	.085	94.000	89.000	3.0000	387.000	-80.000	.2500	1273.71
3	10	2.00	977.4700	.075	95.000	90.000	3.0000	390.000	-85.000	.2500	1198.56
3	11	2.00	978.0100	.080	88.000	89.000	3.0000	380.000	-80.000	.2500	1230.57
3	12	2.00	978.4650	.050	89.000	89.000	3.0000	373.000	-77.000	.2500	968.79
3	13	2.00	978.8500	.077	90.000	90.000	3.0000	377.000	-77.000	.2500	1205.12
3	14	2.00	979.5700	.080	92.000	90.000	3.0000	382.000	-80.000	.2500	1232.03
3	15	2.00	980.0000	.087	93.000	90.000	4.0000	385.000	-83.000	.2500	1287.09
3	16	2.00	980.5300	.075	94.000	90.000	4.0000	392.000	-83.000	.2500	1199.97
3	17	2.00	981.1320	.118	95.000	91.000	4.0000	385.000	-85.000	.2500	1498.96
3	18	2.00	981.7400	.097	96.000	91.000	4.0000	397.000	-85.000	.2500	1368.66
3	19	2.00	982.3080	.090	98.000	92.000	4.0000	400.000	-83.000	.2500	1320.66
3	20	2.00	982.8920	.100	98.000	92.000	4.0000	425.000	-83.000	.2500	1412.19

P MOIST.	AVE. VEL.	FLOWRATE	ISO. RATIO	EMIS. RATE	PART. LOAD	STD. LOAD
.0742	1202.5424	208890.0	1.0557	3254.1344	1.8175	2.9755

	UNDER 5 MICRONS	5 TO 80 MICRONS	OVER 80 MICRONS
ANISO CORRECTION FACTOR	1.0000	1.0271	1.0557
EMISSION RATE	3254.1344	3342.2363	3435.2415
PART. LOAD	1.8175	1.8667	1.9186
STD. LOAD	2.9755	3.0561	3.1411

TEST: 10/5
100 MW LOAD
125% EXCESS AIR
COAL TYPE A
SOOT BLOWING OVER
PERIOD OF TEST

```
                                        TABLE  A12
                           GRAIN LOADING AT AIR HEATER (LOCATION 2)
                          TEST       DATE
                          105       100671

AIR TEMP.  ATM. PRESS.  STACK VAC.  CONDENSATE PARTICULATE  STACK AREA  INIT. VOL.     PO2       PCO2
   90.00       29.420      7.2000     24.00000      3.54770    43.42700     15.7500     .0700     .1180

PORT     TIME   METER VOL  DELTA P  TEMP. IN  TEMP. OUT  TRAIN VAC.  STK. TEMP.  BOX TEMP.  PROBE DIA.  VELOCITY

4  1     5.00    17.1000     .076     88.000     84.000      2.5000     360.000    -75.000      .2500     1185.21
4  2     5.00    18.4440     .096     91.000     85.000      2.5000     359.000    -75.000      .2500     1331.27
4  3     5.00    19.8550     .088     95.000     87.000      2.5000     358.000    -75.000      .2500     1273.82
4  4     5.00    21.1600     .072     98.000     89.000      2.5000     360.000    -75.000      .2500     1153.62
4  5     5.00    22.5260     .084    100.000     90.000      2.5000     375.000    -75.000      .2500     1257.40
4  6     5.00    23.8600     .070    102.000     93.000      2.5000     371.000    -75.000      .2500     1145.09
4  7     5.00    25.2660     .090    104.000     94.000      2.5000     382.000    -75.000      .2500     1306.97
4  8     5.00    26.6750     .085    106.000     96.000      2.5000     379.000    -75.000      .2500     1267.89
4  9     5.00    27.8720     .057    107.000     98.000      2.5000     380.000    -75.000      .2500     1038.88
4 10     5.00    29.2450     .087    108.000    100.000      3.0000     392.000    -75.000      .2500     1292.62

P MOIST.  AVE. VEL.   FLOWRATE   ISO. RATIO   EMIS. RATE   PART. LOAD   STD. LOAD
  .0823   1225.2793    53210.2       1.0736    1111.9656       2.4381      3.9653

                              UNDER 5 MICRONS   5 TO 80 MICRONS   OVER 80 MICRONS        TEST:  10/6
ANISO CORRECTION FACTOR            1.0000            1.0355            1.0736                   100 MW LOAD
EMISSION RATE                   1111.9656         1151.4202         1193.7777                   125% EXCESS AIR
PART. LOAD                         2.4381            2.5246            2.6174                   COAL TYPE A
STD. LOAD                          3.9653            4.1060            4.2570                   NO SOOT BLOWING
```

TABLE A13

GRAIN LOADING AT AIR HEATER (LOCATION 2)

TEST	DATE
106	100671

AIR TEMP.	ATM. PRESS.	STACK VAC.	CONDENSATE	PARTICULATE	STACK AREA	INIT. VOL.	PO2	PCO2
90.00	29.420	7.2000	35.25000	4.38390	4.34270	29.2450	.0700	.1180

PORT	TIME	METER VOL	DELTA P	TEMP. IN	TEMP. OUT	TRAIN VAC.	STK. TEMP.	BOX TEMP.	PROBE DIA.	VELOCITY
4 7	5.00	30.6900	.086	90.000	92.000	2.5000	390.000	-75.000	.2500	1286.27
4 7	5.00	32.1670	.089	93.000	93.000	2.5000	390.000	-75.000	.2500	1308.52
4 7	5.00	33.6450	.087	99.000	93.000	2.5000	390.000	-75.000	.2500	1293.73
4 7	5.00	35.1100	.087	101.000	94.000	2.5000	387.000	-75.000	.2500	1291.45
4 7	5.00	36.5850	.087	105.000	95.000	3.0000	386.000	-75.000	.2500	1290.68
4 7	5.00	38.0620	.088	107.000	96.000	3.0000	388.000	-75.000	.2500	1299.61
4 7	5.00	39.5400	.087	109.000	98.000	3.0000	388.000	-75.000	.2500	1292.21
4 7	5.00	41.0200	.088	110.000	100.000	3.0000	388.000	-75.000	.2500	1299.61
4 7	5.00	42.5050	.086	111.000	101.000	3.0000	387.000	-75.000	.2500	1284.00
4 7	5.00	43.9920	.088	113.000	102.000	3.5000	390.000	-75.000	.2500	1301.15
4 7	5.00	45.4750	.086	114.000	103.000	3.5000	390.000	-75.000	.2500	1286.27
4 7	5.00	46.9610	.087	115.000	104.000	3.5000	387.000	-75.000	.2500	1291.45

P MOIST.	AVE. VEL.	FLOWRATE	ISO. RATIO	EMIS. RATE	PART. LOAD	STD. LOAD
.0921	1293.7468	5618.4	1.1351	108.2997	2.2489	3.7314

TEST: 10/6
100 MW LOAD
125% EXCESS AIR
COAL TYPE A
NO SOOT BLOWING

	UNDER 5 MICRONS	5 TO 80 MICRONS	OVER 80 MICRONS
ANISO CORRECTION FACTOR	1.0000	1.0633	1.1351
EMISSION RATE	108.2997	115.1518	122.9295
PART. LOAD	2.2489	2.3912	2.5527
STD. LOAD	3.7314	3.9675	4.2354

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                                                   TABLE  A14
                                    GRAIN LOADING AT AIR HEATER (LOCATION 2)
                               TEST        DATE
                               107        100671

AIR TEMP.  ATM. PRESS.  STACK VAC.  CONDENSATE PARTICULATE  STACK AREA  INIT. VOL.    PO2      PCO2
   90.00      29.420      7.2000    31.50000      4.06110     4.34270     46.9610     .0700    .1180

PORT    TIME   METER VOL  DELTA P  TEMP. IN  TEMP. OUT  TRAIN VAC.  STK. TEMP.  BOX TEMP.  PROBE DIA.  VELOCITY

4  7    5.00    48.4770    .103     90.000    92.000     2.5000     393.000    -75.000      .2500    1406.44
4  7    5.00    50.0250    .101     94.000    92.000     2.5000     393.000    -75.000      .2500    1392.72
4  7    5.00    51.5620    .100     97.000    93.000     2.5000     393.000    -75.000      .2500    1385.81
4  7    5.00    53.0950    .100    102.000    94.000     2.5000     390.000    -75.000      .2500    1383.37
4  7    5.00    54.6200    .103    105.000    95.000     3.0000     393.000    -75.000      .2500    1406.44
4  7    5.00    56.1660    .102    107.000    96.000     3.0000     394.000    -75.000      .2500    1400.42
4  7    5.00    57.7390    .104    109.000    97.000     3.0000     396.000    -72.000      .2500    1415.73
4  7    5.00    59.3200    .102    112.000    99.000     3.5000     396.000    -72.000      .2500    1402.06
4  7    5.00    60.8850    .104    112.000   100.000     3.5000     395.000    -72.000      .2500    1414.91
4  7    5.00    62.4480    .104    113.000   101.000     3.5000     393.000    -72.000      .2500    1413.25
4  7    5.00    64.0050    .103    114.000   102.000     3.5000     394.000    -72.000      .2500    1407.26
4  7    5.00    65.5630    .102    114.000   104.000     3.5000     394.000    -72.000      .2500    1400.42

P MOIST.  AVE. VEL.   FLOWRATE   ISO. RATIO   EMIS. RATE   PART. LOAD   STD. LOAD
  .0794   1402.4014    6090.2      1.0914      104.3398       1.9988      3.3369          TEST:  10/6
                                                                                                100 MW LOAD
                              UNDER 5 MICRONS   5 TO 80 MICRONS   OVER 80 MICRONS              125% EXCESS AIR
ANISO CORRECTION FACTOR            1.0000            1.0437            1.0914                  COAL TYPE A
EMISSION RATE                    104.3398          108.9004          113.8778                  NO SOOT BLOWING
PART. LOAD                         1.9988            2.0861            2.1815
STD. LOAD                          3.3369            3.4828            3.6420
```

TABLE A15

GRAIN LOADING AT AIR HEATER (LOCATION 2)

```
                                   TEST      DATE
                                   198      100671

AIR TEMP.  ATM. PRESS.  STACK VAC.  CONDENSATE PARTICULATE  STACK AREA  INIT. VOL.    PO2      PCO2
   98.00       29.420       7.2000     23.25000      3.18820    43.42700     65.5630     .0700    .1180

PORT    TIME    METER VOL  DELTA P  TEMP. IN  TEMP. OUT  TRAIN VAC.  STK. TEMP.  BOX TEMP.  PROBE DIA.  VELOCITY

4  1    5.00    66.8580     .076     84.000     86.000     2.5000     327.000    -75.000       .2500     1160.14
4  2    5.00    68.4100     .102     87.000     86.000     2.5000     357.000    -75.000       .2500     1365.40
4  3    5.00    69.7680     .098     92.000     87.000     3.0000     362.000    -68.000       .2500     1346.36
4  4    5.00    71.0850     .075     95.000     88.000     3.0000     365.000    -70.000       .2500     1179.98
4  5    5.00    72.4660     .091     97.000     89.000     3.0000     381.000    -70.000       .2500     1312.31
4  6    5.00    73.8960     .075     99.000     91.000     3.0000     375.000    -75.000       .2500     1187.11
4  7    5.00    75.2580     .105    101.000     92.000     3.5000     385.000    -70.000       .2500     1413.00
4  8    5.00    76.7170     .106    103.000     93.000     3.5000     377.000    -70.000       .2500     1412.97
4  9    5.00    77.9520     .061    104.000     94.000     3.0000     382.000    -73.000       .2500     1075.08
4 10    5.00    79.3290     .095    104.000     95.000     3.5000     399.000    -70.000       .2500     1355.12

P MOIST.  AVE. VEL.   FLOWRATE   ISO. RATIO   EMIS. RATE   PART. LOAD   STD. LOAD
  .0782   1201.1480    55636.4       1.0465    1025.1626       2.1497      3.4949

                             UNDER 5 MICRONS   5 TO 80 MICRONS   OVER 80 MICRONS       TEST:  10/6
ANISO CORRECTION FACTOR           1.0000            1.0227            1.0465                  100 MW LOAD
EMISSION RATE                  1025.1626         1048.4445         1072.0083                  125% EXCESS AIR
PART. LOAD                        2.1497            2.1985            2.2496                  COAL TYPE A
STD. LOAD                         3.4949            3.5743            3.6573                  NO SOOT BLOWING
```

TABLE A16
GRAIN LOADING AT AIR HEATER (LOCATION 2)

```
                              TEST      DATE
                              109       100871

AIR TEMP.  ATM. PRESS.  STACK VAC.  CONDENSATE PARTICULATE  STACK AREA  INIT. VOL.    PO2      PCO2
   90.00       29.420      2.1500    59.95000      5.11370   173.70700   105.8460    .1080     .0840

PORT    TIME   METER VOL  DELTA P  TEMP. IN  TEMP. OUT  TRAIN VAL.  STK. TEMP.  BOX TEMP.  PROBE DI.   VELOCITY

4  1    2.00   106.9040    .020     77.000    80.000     3.5000     320.000    -65.000      .5000     591.10
4  2    2.00   107.9800    .022     81.000    82.000     3.5000     323.000    -60.000      .5000     621.14
4  3    2.00   109.1770    .023     84.000    82.000     3.5000     326.000    -60.000      .5000     636.32
4  4    2.00   110.1650    .022     88.000    82.000     3.5000     326.000    -60.000      .5000     622.33
4  5    2.00   111.1800    .017     92.000    82.000     3.0000     330.000    -60.000      .5000     548.45
4  6    2.00   112.1250    .015     94.000    82.000     3.0000     332.000    -60.000      .5000     515.83
4  7    2.00   113.0700    .017     95.000    83.000     3.0000     332.000    -60.000      .5000     549.14
4  8    2.00   114.0300    .017     97.000    83.000     3.0000     332.000    -60.000      .5000     549.14
4  9    2.00   114.9000    .012     97.000    83.000     2.5000     333.000    -60.000      .5000     461.66
4 10    2.00   115.7960    .016     97.000    84.000     3.0000     339.000    -65.000      .5000     535.10
4 11    2.00   116.7350    .016     79.000    80.000     3.5000     340.000    -65.000      .5000     535.43
4 12    2.00   117.7500    .015     81.000    80.000     3.0000     338.000    -60.000      .5000     517.78
4 13    2.00   118.5820    .017     82.000    80.000     3.5000     341.000    -60.000      .5000     552.25
4 14    2.00   119.5400    .017     85.000    81.000     3.5000     341.000    -60.000      .5000     552.25
4 15    2.00   120.5650    .015     88.000    81.000     3.0000     347.000    -60.000      .5000     520.59
4 16    2.00   121.4100    .017     90.000    82.000     3.5000     348.000    -60.000      .5000     554.66
4 17    2.00   122.3270    .015     92.000    82.000     3.5000     348.000    -60.000      .5000     521.01
4 18    2.00   123.2810    .017     93.000    83.000     3.5000     346.000    -60.000      .5000     554.66
4 19    2.00   124.2250    .016     94.000    83.000     3.5000     355.000    -60.000      .5000     540.43
4 20    2.00   125.1640    .016     95.000    83.000     3.5000     364.000    -60.000      .5000     543.40
3  1    2.00   125.8900    .008     69.000    70.000     2.5000     310.000    -60.000      .5000     371.44
3  2    2.00   126.7920    .010     70.000    70.000     2.5000     332.000    -55.000      .5000     421.17
3  3    2.00   127.6280    .017     72.000    70.000     3.5000     334.000    -55.000      .5000     549.64
3  4    2.00   128.5530    .012     75.000    70.000     3.5000     333.000    -53.000      .5000     461.66
3  5    2.00   129.3940    .010     77.000    71.000     3.0000     335.000    -53.000      .5000     421.97
3  6    2.00   130.2270    .010     79.000    71.000     3.0000     335.000    -53.000      .5000     421.97
3  7    2.00   131.1620    .015     82.000    72.000     4.0000     344.000    -55.000      .5000     519.72
3  8    2.00   133.1100    .017     69.000    70.000     4.0000     340.000    -65.000      .5000     551.41
3  9    2.00   134.0600    .016     70.000    71.000     3.5000     346.000    -60.000      .5000     537.44
3 10    2.00   134.9610    .015     73.000    71.000     3.5000     347.000    -60.000      .5000     520.69
3 11    2.00   135.8250    .014     68.000    70.000     3.5000     340.000    -60.000      .5000     500.85
3 12    2.00   136.7930    .015     70.000    70.000     3.5000     332.000    -55.000      .5000     515.83
3 13    2.00   137.5970    .017     73.000    70.000     4.0000     336.000    -53.000      .5000     550.53
3 14    2.00   138.5280    .016     75.000    71.000     4.0000     338.000    -53.000      .5000     534.76
3 15    2.00   139.4340    .015     79.000    71.000     4.0000     338.000    -53.000      .5000     [illegible]
3 16    2.00   140.3700    .017     80.000    72.000     4.0000     343.000    -53.000      .5000     556.72
3 17    2.00   141.4360    .035     86.000    82.000     5.5000     354.000    -53.000      .5000     798.81
3 18    2.00   142.9150    .055     89.000    83.000     8.0000     354.000    -53.000      .5000    1002.54
3 19    2.00   144.6810    .060     93.000    84.000     8.0000     356.000    -55.000      .5000    1046.53
3 20    2.00   146.4930    .090     99.000    75.000    12.0000     375.000    -55.000      .5000    1297.37

P MOIST.  AVE. VEL.   FLOWRATE   ISO. RATIO   EMIS. RATE   PART. LOAD   STD. LOAD
  .0675   576.1004    100420.1      1.0308    1043.3370       1.2121      1.8758

                             UNDER 5 MICRONS   5 TO 80 MICRONS   OVER 80 MICRONS
ANISO CORRECTION FACTOR          1.0000             1.0152            1.0308
EMISSION RATE                 1043.3370          1059.1491         1075.4478
PART. LOAD                       1.2121             1.2305            1.2494
STD. LOAD                        1.8758             1.9042            1.9335
```

TEST: 10/8
35 MW LOAD
145% EXCESS AIR
COAL TYPE A
NO SOOT BLOWING

APPENDIX B

DATA MANAGEMENT LOG

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DATA MANAGEMENT LOG

TEST NO. ____________________ DATE ______________________

TEST START TIME _____________

TEST END TIME ______________

EXPECTED VARIABLES

LOAD FACTOR - 35 50 75 100

FUEL TYPE - A B C

SOOT BLOWER - NONE MAX MIN

EXCESS AIR - NORMAL MAX MIN

BURNER ANGLE - NORMAL MAX MIN

COAL AND REFUSE SAMPLING

	NO. OF SAMPLES	AGG LABELED	LABEL ID	SENT TO ISGS	SENTO MRI	ANALYSIS RCVD MITRE
COAL						
MECH SEP. ASH						
PIT ASH						

COMMENTS ON COAL AND REFUSE SUBSYSTEM:

DATA MANAGEMENT LOG

TEST NO. ____ (CONT) P. 2

TEMP. MONITORING

	TIME START	TIME END	HOURS OF DATA	LABEL ID	SENT TO MITRE	RCVD MITRE
AIR TEMP. ENT AH						
AIR TEMP. LV AH						
GAS TEMP. LV ECON						
GAS TEMP. LV AH						
AIR TEMP. ENT FD FAN						
HUMIDITY ENT FD FAN						
TEMP. REF. JUNCTION						

COMMENTS ON TEMPERATURE SUBSYSTEM:

CONTINUOUS FLUE GAS MONITORING

	TIME START	TIME END	HOURS OF DATA	LABEL ID	SENT TO MITRE	RCVD MITRE
LOC 1 TEMP						
LOC 1 PRESSURE						

DATA MANAGEMENT LOG

TEST NO. ____ (CONT) P. 3

	TIME START	TIME END	HOURS OF DATA	LABEL ID	SENT TO MITRE	RCVD MITRE
LOC 1 FLOW						
LOC 1 SO_2						
LOC 1 O_2						
LOC 2 TEMP.						
LOC 2 PRESSURE						
LOC 2 FLOW						
LOC 2 PARTICULATES						
LOC 3 TEMP.						
LOC 3 PRESSURE						
LOC 3 FLOW						
LOC 3 PARTICULATES						
LOC 3 SO_2						
LOC 3 NO_x						
LOC 3 CO & CO_2						
LOC 3 HC						
LOC 3 O_2						
LOC 3 H_2OVAPOR						

COMMENTS ON CONTINUOUS FLUE GAS MONITORING:

DATA MANAGEMENT LOG

TEST NO. ____ (CONT) P. 4

MANUAL FLUE GAS SAMPLING

	NO. OF SAMPLES	SAMPLE TIME	LABEL ID	SENT TO MRI	RCVD MITRE
LOC 1 SO_2					
LOC 1 NO_x					
LOC 1 CO & CO_2					
LOC 2 MASS LOADING					
LOC 3 MASS LOADING					
LOC 3 H_2SO_4 MIST					
LOC 3 SO_2					
LOC 3 NO_x					
LOC 3 CO & CO_2					

COMMENTS ON MANUAL FLUE GAS SAMPLING:

OPERATING CONDITIONS LOG

SAMPLE HOURS ______________ OCLOCK ______________ OCLOCK

______________ OCLOCK ______________ OCLOCK

DATA MANAGEMENT LOG

TEST NO. ____ (CONT) P. 5

__________ OCLOCK __________ OCLOCK
__________ OCLOCK __________ OCLOCK
__________ OCLOCK __________ OCLOCK
PRINT OUTS __________ OCLOCK __________ OCLOCK
__________ OCLOCK __________ OCLOCK
__________ OCLOCK __________ OCLOCK
__________ OCLOCK __________ OCLOCK
__________ OCLOCK __________ OCLOCK

	LABEL ID	SENT TO MITRE	RCVD MITRE
OP. COND. LOG			
PRINT OUTS			

COMMENTS ON OPERATING CONDITIONS:

QUICK LOOK LOG AND COMPUTATIONS

NET EFF COMPUTATION ________ OCLOCK ______ OCLOCK _____ OCLOCK
GROSS EFF COMPUTATION ________ OCLOCK ______ OCLOCK _____ OCLOCK
FLOW COMPUTATION ________ OCLOCK ______ OCLOCK _____ OCLOCK

DATA MANAGEMENT LOG

TEST NO. ____ (CONT) P. 6

MASS FLOW COMPUTATION __ __ OCLOCK ______ OCLOCK ______ OCLOCK

OTHER COMPUTATION ______ OCLOCK ______ OCLOCK ______ OCLOCK

NUMBER OF DATA SHEETS ______

	LABEL ID	SENT TO MITRE	RCVD MITRE
QUICK LOOK LOG			
QUICK LOOK COMPUTATIONS			
DATA SHEETS			

COMMENTS ON QUICK LOOK:

PERSONNEL

MITRE	MRI	WOODRIVER
TEST DIRECTOR	PARTY CHIEF	SUPERVISOR
DATA HANDLER	OTHERS	
OTHERS		

DATA MANAGEMENT LOG

TEST NO. ____ (CONT) P. 7

COMMENTS OF TEST DIRECTOR

TEST DIRECTOR SIGNATURE

DATA HANDLER SIGNATURE

APPENDIX C

DATA BASE

```
SELECTION CARDS
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23

EFFICIENCY OPTION CARDS

EXCESS AIR OPTION CARDS

FLOW RATE OPTION CARDS
```

```
RECORD TYPE  TEST   DATE   TIME  LCC  METH

CONSTANTS                             LEAKAGE      =    .1
FLOW          11                1    1  TEMPERATURE =  700  STATIC PRES =     2  VELOCITY    =
FLOW          09                1    1  TEMPERATURE =  700  STATIC PRES =     2  VELOCITY    =
FLOW          08                1    1  TEMPERATURE =  700  STATIC PRES =     2  VELOCITY    =
FLOW          12                1    1  TEMPERATURE =  700  STATIC PRES =     2  VELOCITY    =
FLOW          07                1    1  TEMPERATURE =  700  STATIC PRES =     2  VELOCITY    =
FLOW          01                1    1  TEMPERATURE =  700  STATIC PRES =     2  VELOCITY    =
FLOW          06                1    1  TEMPERATURE =  782  STATIC PRES =   5.2  VELOCITY    =
FLOW          18                1    1  TEMPERATURE =  712  STATIC PRES =   1.9  VELOCITY    =
FLOW          13                1    1  TEMPERATURE =  662  STATIC PRES =   1.3  VELOCITY    =
FLOW          04                1    1  TEMPERATURE =  712  STATIC PRES =   2.6  VELOCITY    =
FLOW          05                1    1  TEMPERATURE =  712  STATIC PRES =   2.7  VELOCITY    =
FLOW          10                1    1  TEMPERATURE =  732  STATIC PRES =   4.3  VELOCITY    =
FLOW          20                1    1  TEMPERATURE =  672  STATIC PRES =   1.8  VELOCITY    =
FLOW          02                1    1  TEMPERATURE =  692  STATIC PRES =   2.8  VELOCITY    =
FLOW          03                1    1  TEMPERATURE =  712  STATIC PRES =   3.3  VELOCITY    =
FLOW          17                1    1  TEMPERATURE =  632  STATIC PRES =  1.65  VELOCITY    =
FLOW          19                1    1  TEMPERATURE =  692  STATIC PRES =   1.8  VELOCITY    =
FLOW          21                1    1  TEMPERATURE =  662  STATIC PRES =   1.2  VELOCITY    =
FLOW          14                1    1  TEMPERATURE =  692  STATIC PRES =   1.5  VELOCITY    =
FLOW          15                1    1  TEMPERATURE =  652  STATIC PRES =   1.6  VELOCITY    =
FLOW          22                1    1  TEMPERATURE =  742  STATIC PRES =   2.4  VELOCITY    =
FLOW          11                1    0  TEMPERATURE =       STATIC PRES =        VELOCITY    =  1466
FLOW          09                1    0  TEMPERATURE =       STATIC PRES =        VELOCITY    =  1222
FLOW          08                1    0  TEMPERATURE =       STATIC PRES =        VELOCITY    =  1426
FLOW          12                1    0  TEMPERATURE =       STATIC PRES =        VELOCITY    =  1264
FLOW          07                1    0  TEMPERATURE =       STATIC PRES =        VELOCITY    =  1323
```

```
RECORD TYPE  TEST   DATE   TIME  LOC  METH

FLOW          01                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    = 1055
FLOW          06                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    = 1582
FLOW          18                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    =  775
FLOW          13                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    =  589
FLOW          04                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    =  970
FLOW          05                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    = 1089
FLOW          10                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    = 1256
FLOW          20                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    =  721
FLOW          02                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    =  999
FLOW          03                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    = 1166
FLOW          17                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    =  632
FLOW          19                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    =  810
FLOW          21                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    =  565
FLOW          14                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    =  661
FLOW          15                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    =  685
FLOW          22                 1    0   TEMPERATURE =       STATIC PRES =       VELOCITY    = 1976
FLOW          11                 2    0   TEMPERATURE =  363  STATIC PRES =    7  VELOCITY    = 1267
FLOW          09                 2    0   TEMPERATURE =  368  STATIC PRES =    7  VELOCITY    = 1076
FLOW          08                 2    0   TEMPERATURE =  376  STATIC PRES =  8.9  VELOCITY    = 1290
FLOW          12                 2    0   TEMPERATURE =  375  STATIC PRES =  6.5  VELOCITY    = 1134
FLOW          07                 2    0   TEMPERATURE =  301  STATIC PRES =  7.7  VELOCITY    = 1207
FLOW          01                 2    0   TEMPERATURE =  382  STATIC PRES = 5.25  VELOCITY    =  961
FLOW          06                 2    0   TEMPERATURE =  392  STATIC PRES = 7.85  VELOCITY    = 1321
FLOW          18                 2    0   TEMPERATURE =  357  STATIC PRES =    3  VELOCITY    =  645
FLOW          13                 2    0   TEMPERATURE =  337  STATIC PRES = 2.10  VELOCITY    =  458
FLOW          04                 2    0   TEMPERATURE =  373  STATIC PRES = 4.50  VELOCITY    =  845
FLOW          05                 2    0   TEMPERATURE =  348  STATIC PRES = 4.85  VELOCITY    =  886
```

```
RECORD TYPE  TEST   CATE   TIME  LCC  METH

FLOW         10                 2    0   TEMPERATURE =   360  STATIC PRES =  7.20  VELOCITY    =  1063
FLCW         20                 2    0   TEMPERATURE =   315  STATIC PRES =  2.70  VELOCITY    =   561
FLCW         02                 2    0   TEMPERATURE =   361  STATIC PRES =  4.60  VELCCITY    =   867
FLOW         03                 2    0   TEMPERATURE =   366  STATIC PRES =  5.50  VELOCITY    =   988
FLCW         17                 2    0   TEMPERATURE =   353  STATIC PRES =  2.70  VELCCITY    =   586
FLCW         19                 2    0   TEMPERATURE =   340  STATIC PRES =  3.25  VELOCITY    =   662
FLOW         21                 2    0   TEMPERATURE =   353  STATIC PRES =  2.10  VELCCITY    =   500
FLCW         14                 2    0   TEMPERATURE =   374  STATIC PRES =  2.65  VELOCITY    =   593
FLOW         15                 2    0   TEMPERATURE =   359  STATIC PRES =  2.75  VELOCITY    =   590
FLOW         22                 2    0   TEMPERATURE =   368  STATIC PRES =  4.85  VELCCITY    =   889
FLCW         11                 3    0   TEMPERATURE =   296  STATIC PRES =   .57  VELOCITY    =  2032
FLOW         09                 3    0   TEMPERATURE =   292  STATIC PRES =   .64  VELCCITY    =  1934
FLCW         08                 3    0   TEMPERATURE =   304  STATIC PRES =   .49  VELOCITY    =   955
FLOW         12                 3    0   TEMPERATURE =   302  STATIC PRES =   .51  VELOCITY    =   870
FLCW         07                 3    0   TEMPERATURE =   308  STATIC PRES =   .48  VELCCITY    =   888
FLOW         01                 3    0   TEMPERATURE =   312  STATIC PRES =   .51  VELOCITY    =   718
FLOW         06                 3    0   TEMPERATURE =   309  STATIC PRES =   .49  VELCCITY    =   907
FLOW         18                 3    0   TEMPERATURE =   285  STATIC PRES =   .52  VELOCITY    =   463
FLCW         13                 3    0   TEMPERATURE =   266  STATIC PRES =   .48  VELCCITY    =   360
FLCW         04                 3    0   TEMPERATURE =   292  STATIC PRES =   .49  VELCCITY    =   655
FLOW         05                 3    0   TEMPERATURE =   272  STATIC PRES =   .48  VELCCITY    =   596
FLCW         10                 3    0   TEMPERATURE =   290  STATIC PRES =   .60  VELCCITY    =   807
FLCW         20                 3    0   TEMPERATURE =   253  STATIC PRES =   .61  VELOCITY    =   405
FLOW         02                 3    0   TEMPERATURE =   283  STATIC PRES =   .64  VELOCITY    =   584
FLCW         03                 3    0   TEMPERATURE =   286  STATIC PRES =   .63  VELCCITY    =   703
FLOW         17                 3    0   TEMPERATURE =   276  STATIC PRES =   .60  VELOCITY    =   410
FLCW         19                 3    0   TEMPERATURE =   273  STATIC PRES =   .56  VELCCITY    =   472
```

```
RECORD TYPE  TEST   DATE   TIME  LCC  PETH

FLLW          21                  3     0   TEMPERATURE =   261  STATIC PRES =   .55  VELCCITY    =   347
FLOW          14                  3     0   TEMPERATURE =   284  STATIC PRES =   .52  VELOCITY    =   430
FLOW          15                  3     0   TEMPERATURE =   278  STATIC PRES =   .56  VELCCITY    =   420
FLOW          22                  3     0   TEMPERATURE =   294  STATIC PRES =   .53  VELOCITY    =   651
DUCT                              1         AREA        = 511.3
DUCT                              2         AREA        = 347.5
DUCT                              3         AREA        = 444.9
COAL          11                            ASH         = .1003  CARBON       = .6819  HYDROGEN    = .0520  NITROGEN    = .0126
                                            SULFUR      = .0334  MOISTURE     = .0384  HEAT VALUE  = 12111
COAL          09                            ASH         = .0989  CARBON       = .6923  HYDROGEN    = .0524  NITROGEN    = .0132
                                            SULFUR      = .0337  MOISTURE     = .0366  HEAT VALUE  = 12232
COAL          08                            ASH         = .1025  CARBON       = .6892  HYCROGEN    = .0519  NITROGEN    = .0123
                                            SULFUR      = .0337  MOISTURE     = .0366  HEAT VALUE  = 12163
CCAL          12                            ASH         = .1075  CARBON       = .6770  HYCRCGEN    = .0506  NITROGEN    = .0125
                                            SULFUR      = .0319  MOISTURE     = .0359  HEAT VALUE  = 12051
COAL          07                            ASH         = .1001  CARBON       = .6919  HYCROGEN    = .0517  NITROGEN    = .0126
                                            SULFUR      = .0327  MOISTURE     = .0389  HEAT VALUE  = 12153
COAL          01                            ASH         = .1042  CARBCN       = .6743  HYCROGEN    = .0519  NITROGEN    = .0133
                                            SULFUR      = .0310  MOISTURE     = .0402  HEAT VALUE  = 12117
COAL          06                            ASH         = .1130  CARBON       = .6722  HYDROGEN    = .0510  NITROGEN    = .0124
                                            SULFUR      = .0276  MOISTURE     = .0410  HEAT VALUE  = 12055
COAL          18                            ASH         = .1215  CARBCN       = .6700  HYCROGEN    = .0503  NITROGEN    = .0149
                                            SULFUR      = .0251  MOISTURE     = .0388  HEAT VALUE  = 11813
COAL          13                            ASH         = .1313  CARBON       = .6645  HYCROGEN    = .0495  NITROGEN    = .0134
                                            SULFUR      = .0249  MOISTURE     = .0345  HEAT VALUE  = 11837
COAL          04                            ASH         = .1035  CARBON       = .6774  HYDROGEN    = .0519  NITROGEN    = .0130
                                            SULFUR      = .0333  MOISTURE     = .0431  HEAT VALUE  = 12086
COAL          05                            ASH         = .1357  CARBON       = .6672  HYDROGEN    = .0498  NITROGEN    = .0146
                                            SULFUR      = .0182  MOISTURE     = .0369  HEAT VALUE  = 11814
COAL          10                            ASH         = .1669  CARBON       = .6427  HYCRCGEN    = .0464  NITROGEN    = .0143
                                            SULFUR      = .0165  MOISTURE     = .0329  HEAT VALUE  = 11333
COAL          20                            ASH         = .1594  CARBON       = .6480  HYCROGEN    = .0472  NITROGEN    = .0130
                                            SULFUR      = .0168  MOISTURE     = .0404  HEAT VALUE  = 11184
COAL          02                            ASH         = .0985  CARBON       = .6808  HYCROGEN    = .0513  NITROGEN    = .0116
                                            SULFUR      = .0287  MOISTURE     = .0452  HEAT VALUE  = 12092
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RECORD TYPE  TEST   DATE   TIME  LCC  METH

CCAL          03                            ASH          = .1000  CARBON       = .6777  HYDROGEN     = .0505  NITROGEN    = .0126
                                            SULFUR       = .0330  MOISTURE     = .0413  HEAT VALUE   = 12138

COAL          17                            ASH          = .1014  CARBCN       = .6767  HYCRCGEN     = .0509  NITROGEN    = .0112
                                            SULFUR       = .0342  MOISTURE     = .0412  HEAT VALUE   = 12116

COAL          19                            ASH          = .0956  CARBON       = .6819  HYCROGEN     = .0512  NITROGEN    = .0113
                                            SULFUR       = .0339  MOISTURE     = .0408  HEAT VALUF   = 12213

COAL          21                            ASH          = .0914  CARBON       = .6885  HYCROGEN     = .0512  NITROGEN    = .0133
                                            SULFUR       = .0302  MOISTURE     = .0400  HEAT VALUE   = 12344

COAL          14                            ASH          = .1078  CARBON       = .6735  HYCROGEN     = .0506  NITROGFN    = .0133
                                            SULFUR       = .0274  MOISTURE     = .0458  HEAT VALUE   = 12062

COAL          15                            ASH          = .1044  CARBCN       = .6750  HYCROGEN     = .0508  NITROGEN    = .0130
                                            SULFUR       = .0345  MOISTURE     = .0430  HEAT VALUF   = 12017

COAL          22                            ASH          = .0661  CARBCN       = .7228  HYDROGEN     = .0523  NITROGEN    = .0167
                                            SULFUR       = .0132  MOISTURE     = .0417  HEAT VALUE   = 12781

GAS           05                            CARBCN       = .7238  HYDROGEN     = .2545  NITROGEN     = .0049  SULFUR      =      0
                                            HEAT VALUE   = 22447  SP. GR.      =  .588

GAS           10                            CARBON       = .7240  HYDROGEN     = .2450  NITROGEN     = .0075  SULFUR      =      0
                                            HEAT VALUE   = 22460  SP. GR.      =  .587

GAS           20                            CARBON       = .7360  HYDROGEN     = .2450  NITRCGEN     = .0057  SULFUR      =      0
                                            HEAT VALUE   = 22630  SP. GR.      =  .585

FLLE GAS      11                  1    0    CC2          =        C2           =        CO           =       N2          =
                                            SO2          =        UHC          =        MOL WGT(HC)  =       HEAT(UHC)   =
                                            NO           =        NO2          =

FLUE GAS      11   081171  2200   1    1    CC2          =        C2           =        CC           =       N2          =
                                            SO2          =  1965  UHC          =        MOL WGT(HC)  =       HEAT(UHC)   =
                                            NC           =        NO2          =

FLUE GAS      11   081171  2300   1    1    CC2          =        C2           =  .046  CC           =       N2          =
                                            SO2          =  2085  UHC          =        MOL WGT(HC)  =       HEAT(UHC)   =
                                            NC           =        NC2          =

FLUE GAS      11   081171  0000   1    1    CC2          =        O2           =  .046  CC           =       N2          =
                                            SO2          =  2085  UHC          =        MOL WGT(HC)  =       HEAT(UHC)   =
                                            NC           =        NO2          =

FLUE GAS      11   091171  0100   1    1    CO2          =        C2           =  .046  CO           =       N2          =
                                            SC2          =  2085  UHC          =        MOL WGT(HC)  =       HEAT(UHC)   =
                                            NO           =        NO2          =

FLUE GAS      11                  2    0    CC2          =        O2           =        CO           =       N2          =
                                            SO2          =        UHC          =        MOL WGT(HC)  =       HEAT(UHC)   =
                                            NO           =   397  NO2          =
RECORD TYPE  TEST   DATE   TIME  LCC  METH

FLUE GAS      11                  2    X   CO2           =         O2           =         CO            =     N2          =
                                           SO2           =         UHC          =         MOL WGT(HC) =       HEAT(UHC)   =
                                           NO            =         NO2          =

FLUE GAS      11                  3    0   CO2           = .0770   O2           =         CO            =     N2          =
                                           SO2           =         UHC          =         MOL WGT(HC) =       HEAT(UHC)   =
                                           NO            =   651   NO2          =

FLUE GAS      11                  3    X   CO2           = .1080   O2           = .0840   CO            =     N2          =
                                           SO2           =         UHC          =         MOL WGT(HC) =       HEAT(UHC)   =
                                           NO            =         NO2          =

FLUE GAS      09                  1    0   CO2           = .1025   O2           =         CO            =     N2          =
                                           SO2           =         UHC          =         MOL WGT(HC) =       HEAT(UHC)   =
                                           NO            =         NO2          =

FLUE GAS      09   091171  1200   1    1   CO2           =         O2           = .027    CO            =     N2          =
                                           SO2           =  2400   UHC          =         MOL WGT(HC) =       HEAT(UHC)   =
                                           NO            =         NO2          =

FLUE GAS      09   091171  1300   1    1   CO2           =         O2           = .027    CO            =     N2          =
                                           SO2           =  2400   UHC          =         MOL WGT(HC) =       HEAT(UHC)   =
                                           NO            =         NO2          =

FLUE GAS      09   091171  1400   1    1   CO2           =         O2           = .028    CO            =     N2          =
                                           SO2           =  2370   UHC          =         MOL WGT(HC) =       HEAT(UHC)   =
                                           NO            =         NO2          =

FLUE GAS      09   091171  1500   1    1   CO2           =         O2           = .028    CO            =     N2          =
                                           SO2           =  1980   UHC          =         MOL WGT(HC) =       HEAT(UHC)   =
                                           NO            =         NO2          =

FLUE GAS      09   091171  1600   1    1   CO2           =         O2           = .029    CO            =     N2          =
                                           SO2           =  2040   UHC          =         MOL WGT(HC) =       HEAT(UHC)   =
                                           NO            =         NO2          =

FLUE GAS      09   091171  1700   1    1   CO2           =         O2           = .026    CO            =     N2          =
                                           SO2           =  2070   UHC          =         MOL WGT(HC) =       HEAT(UHC)   =
                                           NO            =         NO2          =

FLUE GAS      09   091171  1800   1    1   CO2           =         O2           = .025    CO            =     N2          =
                                           SO2           =  2160   UHC          =         MOL WGT(HC) =       HEAT(UHC)   =
                                           NO            =         NO2          =

FLUE GAS      09   091171  1900   1    1   CO2           =         O2           = .027    CO            =     N2          =
                                           SO2           =  2220   UHC          =         MOL WGT(HC) =       HEAT(UHC)   =
                                           NO            =         NO2          =

FLUE GAS      09   091171  2000   1    1   CO2           =         O2           = .036    CO            =     N2          =
                                           SO2           =  2340   UHC          =         MOL WGT(HC) =       HEAT(UHC)   =
                                           NO            =         NO2          =

FLUE GAS      09                  2    0   CO2           =         O2           =         CO            =     N2          =
                                           SO2           =         UHC          =         MOL WGT(HC) =       HEAT(UHC)   =
                                           NO            =   347   NO2          =
RECORD TYPE  TEST   DATE   TIME  LOC  METH

FLUE GAS      09                 2     X   CO2         = .1080  O2          = .0840  CO             =       N2          =
                                           SO2         =        UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                           NO          =        NO2         =

FLUE GAS      09                 3     0   CO2         = .0230  O2          =        CO             =       N2          =
                                           SO2         =        UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                           NO          =   394  NO2         =

FLUE GAS      09                 3     X   CO2         = .1280  O2          = .0580  CO             =       N2          =
                                           SO2         =        UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                           NO          =        NO2         =

FLUE GAS      08                 1     0   CO2         = .0720  O2          =        CO             =       N2          =
                                           SO2         =  2541  UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                           NO          =        NO2         =

FLUE GAS      08   101171  1500  1     1   CO2         =        O2          =  .050  CO             =       N2          =
                                           SO2         =  2220  UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                           NO          =        NO2         =

FLUE GAS      08   101171  1600  1     1   CO2         =        O2          =  .050  CO             =       N2          =
                                           SO2         =  2205  UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                           NO          =        NO2         =

FLUE GAS      08   101171  1700  1     1   CO2         =        O2          =  .050  CO             =       N2          =
                                           SO2         =  2205  UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                           NO          =        NO2         =

FLUE GAS      08   101171  1800  1     1   CO2         =        O2          =  .050  CO             =       N2          =
                                           SO2         =  2235  UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                           NO          =        NO2         =

FLUE GAS      08                 2     0   CO2         =        O2          =        CO             =       N2          =
                                           SO2         =        UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                           NO          =   433  NO2         =

FLUE GAS      08                 2     X   CO2         = .1150  O2          = .0800  CO             =       N2          =
                                           SO2         =        UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                           NO          =        NO2         =

FLUE GAS      08                 3     0   CO2         = .0860  O2          =        CO             =       N2          =
                                           SO2         =  1306  UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                           NO          =   522  NO2         =

FLUE GAS      08                 3     X   CO2         = .1100  O2          = .0700  CO             =       N2          =
                                           SO2         =        UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                           NO          =        NO2         =

FLUE GAS      12                 1     0   CO2         = .0190  O2          =        CO             =       N2          =
                                           SO2         =  1884  UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                           NO          =        NO2         =

FLUE GAS      12   111171  1100  1     1   CO2         =        O2          =  .037  CO             =       N2          =
                                           SO2         =  2370  UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                           NO          =        NO2         =
RECORD TYPE  TEST   DATE   TIME  LOC  METH

FLUE GAS      12   111171  1200   1    1   CO2        =       O2        = .036  CO           =       N2          =
                                           SO2        =  2340 UHC       =       MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =       NO2       =

FLUE GAS      12   111171  1300   1    1   CO2        =       O2        = .035  CO           =       N2          =
                                           SO2        =  2295 UHC       =       MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =       NO2       =

FLUE GAS      12   111171  1400   1    1   CO2        =       O2        = .037  CO           =       N2          =
                                           SO2        =  2265 UHC       =       MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =       NO2       =

FLUE GAS      12   111171  1500   1    1   CO2        =       O2        = .039  CO           =       N2          =
                                           SO2        =  2250 UHC       =       MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =       NO2       =

FLUE GAS      12   111171  1600   1    1   CO2        =       O2        = .028  CO           =       N2          =
                                           SO2        =  2250 UHC       =       MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =       NO2       =

FLUE GAS      12   111171  1700   1    1   CO2        =       O2        = .038  CO           =       N2          =
                                           SO2        =  2235 UHC       =       MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =       NO2       =

FLUE GAS      12   111171  1800   1    1   CO2        =       O2        = .037  CO           =       N2          =
                                           SO2        =  2250 UHC       =       MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =       NO2       =

FLUE GAS      12                  2    0   CO2        =       O2        =       CO           =       N2          =
                                           SO2        =       UHC       =       MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =   509 NO2       =

FLUE GAS      12                  2    X   CO2        = .1250 O2        = .0650 CO           =       N2          =
                                           SO2        =       UHC       =       MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =       NO2       =

FLUE GAS      12                  3    0   CO2        = .0780 O2        =       CO           =       N2          =
                                           SO2        =  1703 UHC       =       MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =   392 NO2       =

FLUE GAS      12   111171  1800   3    1   CO2        =       O2        =       CO           =       N2          =
                                           SO2        =  1755 UHC       =       MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =       NO2       =

FLUE GAS      12                  3    X   CO2        = .1225 O2        = .0800 CO           =       N2          =
                                           SO2        =       UHC       =       MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =       NO2       =

FLUE GAS      07                  1    0   CO2        = .0735 O2        =       CO           =       N2          =
                                           SO2        =  1571 UHC       =       MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =       NO2       =

FLUE GAS      07   121171  0900   1    1   CO2        =       O2        = .035  CO           =       N2          =
                                           SO2        =  2295 UHC       =       MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =       NO2       =
RECORD TYPE  TEST   DATE   TIME  LCC  METH

FLUE GAS      07   121171  1000   1     1   CO2         =        O2          = .C35  CO            =       N2          =
                                            SO2         =  2340  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLUE GAS      07   121171  110C   1     1   CO2         =        O2          = .037  CC            =       N2          =
                                            SO2         =  2295  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLUE GAS      07   121171  1200   1     1   CC2         =        O2          = .C37  CO            =       N2          =
                                            SO2         =  2280  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLUE GAS      07   121171  1300   1     1   CC2         =        O2          = .036  CO            =       N2          =
                                            SO2         =  2325  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLUE GAS      07   121171  1400   1     1   CC2         =        O2          = .034  CC            =       N2          =
                                            SC2         =  2355  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLUE GAS      07   121171  1500   1     1   CC2         =        O2          = .033  CO            =       N2          =
                                            SO2         =  2885  UHC         =       MCL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLUE GAS      07   121171  160C   1     1   CC2         =        C2          = .034  CC            =       N2          =
                                            SO2         =  2370  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLUE GAS      07   121171  1700   1     1   CO2         =        C2          = .035  CC            =       N2          =
                                            SO2         =  2370  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLUE GAS      07   121171  1800   1     1   CO2         =        C2          = .035  CC            =       N2          =
                                            SO2         =  2370  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLUE GAS      07   121171  1500   1     1   CO2         =        O2          = .035  CC            =       N2          =
                                            SO2         =  2445  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NC          =        NO2         =

FLUE GAS      07                  2     0   CO2         =        C2          =       CC            =       N2          =
                                            SC2         =        UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =   325  NO2         =

FLUE GAS      07                  2     X   CO2         = .1300  C2          =.0600  CC            =       N2          =
                                            SO2         =        UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLUE GAS      07                  3     0   CO2         = .0235  O2          =       CO            =       N2          =
                                            SO2         =  1800  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =   379  NO2         =

FLUE GAS      07   121171  1300   3     1   CO2         =  .135  O2          = .044  CO            =       N2          =
                                            SC2         =  1935  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =
RECORD TYPE  TEST   DATE   TIME  LOC  METH

FLUE GAS      07   121171  1400   3     1   CO2      =  .135  O2      =  .062  CO            =     N2          =
                                            SO2      =  1965  UHC     =        MOL WGT(HC) =     HEAT(UHC)   =
                                            NO       =        NO2     =

FLUE GAS      07   121171  1500   3     1   CO2      =  .135  O2      =  .062  CO            =     N2          =
                                            SO2      =  1995  UHC     =        MOL WGT(HC) =     HEAT(UHC)   =
                                            NO       =        NO2     =

FLUE GAS      07   121171  1600   3     1   CO2      =  .135  O2      =  .066  CO            =     N2          =
                                            SO2      =  2100  UHC     =        MOL WGT(HC) =     HEAT(UHC)   =
                                            NO       =        NO2     =

FLUE GAS      07   121171  1700   3     1   CO2      =  .135  O2      =  .068  CO            =     N2          =
                                            SO2      =  2085  UHC     =        MOL WGT(HC) =     HEAT(UHC)   =
                                            NO       =        NO2     =

FLUE GAS      07   121171  1800   3     1   CO2      =  .135  O2      =  .069  CO            =     N2          =
                                            SO2      =  2085  UHC     =        MOL WGT(HC) =     HEAT(UHC)   =
                                            NO       =        NO2     =

FLUE GAS      07   121171  1900   3     1   CO2      =  .135  O2      =  .067  CO            =     N2          =
                                            SO2      =  2130  UHC     =        MOL WGT(HC) =     HEAT(UHC)   =
                                            NO       =        NO2     =

FLUE GAS      07                  3     X   CO2      = .1250  O2      = .0600  CO            =     N2          =
                                            SO2      =        UHC     =        MOL WGT(HC) =     HEAT(UHC)   =
                                            NO       =        NO2     =

FLUE GAS      01                  1     C   CO2      = .0595  O2      =        CO            =     N2          =
                                            SO2      =  1582  UHC     =        MOL WGT(HC) =     HEAT(UHC)   =
                                            NO       =        NO2     =

FLUE GAS      01   141171  2100   1     1   CO2      =        O2      =  .039  CO            =     N2          =
                                            SO2      =  2130  UHC     =        MOL WGT(HC) =     HEAT(UHC)   =
                                            NO       =        NO2     =

FLUE GAS      01   141171  2200   1     1   CO2      =        O2      =  .042  CO            =     N2          =
                                            SO2      =  2100  UHC     =        MOL WGT(HC) =     HEAT(UHC)   =
                                            NO       =        NO2     =

FLUE GAS      01   141171  2300   1     1   CO2      =        O2      =  .048  CO            =     N2          =
                                            SO2      =  2040  UHC     =        MOL WGT(HC) =     HEAT(UHC)   =
                                            NO       =        NO2     =

FLUE GAS      01   151171  0000   1     1   CO2      =        O2      =  .049  CO            =     N2          =
                                            SO2      =  2040  UHC     =        MOL WGT(HC) =     HEAT(UHC)   =
                                            NO       =        NO2     =

FLUE GAS      01   151171  0100   1     1   CO2      =        O2      =  .045  CO            =     N2          =
                                            SO2      =  2070  UHC     =        MOL WGT(HC) =     HEAT(UHC)   =
                                            NO       =        NO2     =

FLUE GAS      01   151171  0200   1     1   CO2      =        O2      =  .045  CO            =     N2          =
                                            SO2      =  2070  UHC     =        MOL WGT(HC) =     HEAT(UHC)   =
                                            NO       =        NO2     =
RECORD TYPE  TEST   DATE   TIME  LOC  METH

FLUE GAS      01   151171  0300   1     1   CO2          =        O2          =  .046  CO            =        N2          =
                                            SO2          =  2055  UHC         =        MOL WGT(HC) =        HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      01   151171  0400   1     1   CO2          =        O2          =  .045  CO            =        N2          =
                                            SO2          =  2070  UHC         =        MOL WGT(HC) =        HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      01   151171  0500   1     1   CO2          =        O2          =  .045  CO            =        N2          =
                                            SO2          =  2070  UHC         =        MOL WGT(HC) =        HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      01   151171  0600   1     1   CO2          =        O2          =  .044  CO            =        N2          =
                                            SO2          =  2085  UHC         =        MOL WGT(HC) =        HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      01   151171  0700   1     1   CO2          =        O2          =  .045  CO            =        N2          =
                                            SO2          =  2085  UHC         =        MOL WGT(HC) =        HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      01                  2     C   CO2          =        O2          =        CO            =        N2          =
                                            SO2          =        UHC         =        MOL WGT(HC) =        HEAT(UHC)   =
                                            NO           =   463  NO2         =

FLUE GAS      01                  2     X   CO2          = .1120  O2          = .0820  CO            =        N2          =
                                            SO2          =        UHC         =        MOL WGT(HC) =        HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      01                  3     0   CO2          = .0595  O2          =        CO            =        N2          =
                                            SO2          =  1854  UHC         =        MOL WGT(HC) =        HEAT(UHC)   =
                                            NO           =   440  NO2         =

FLUE GAS      01   151171  0300   3     1   CO2          =  .140  O2          =  .072  CO            =        N2          =
                                            SO2          =        UHC         =        MOL WGT(HC) =        HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      01   151171  0300   3     1   CO2          =        O2          =        CO            =        N2          =
                                            SO2          =        UHC         =        MOL WGT(HC) =        HEAT(UHC)   =
                                            NO           =   350  NO2         =

FLUE GAS      01   151171  0400   3     1   CO2          =  .140  O2          =  .072  CO            =        N2          =
                                            SO2          =        UHC         =        MOL WGT(HC) =        HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      01   151171  0400   3     1   CO2          =        O2          =        CO            =        N2          =
                                            SO2          =        UHC         =        MOL WGT(HC) =        HEAT(UHC)   =
                                            NO           =   370  NO2         =

FLUE GAS      01   151171  0500   3     1   CO2          =  .142  O2          =  .072  CO            =        N2          =
                                            SO2          =        UHC         =        MOL WGT(HC) =        HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      01   151171  0500   3     1   CO2          =        O2          =        CO            =        N2          =
                                            SO2          =        UHC         =        MOL WGT(HC) =        HEAT(UHC)   =
                                            NO           =   380  NO2         =
RECORD TYPE  TEST   CATE   TIME  LCC  METH

FLUE GAS      01   151171  C60C   3     1   CO2          =  .141  O2          =  .070  CO            =      N2          =
                                            SO2          =  1860  UHC         =        MOL WGT(HC) =      HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      01   151171  0600   3     1   CC2          =        O2          =        CO            =      N2          =
                                            SO2          =        UHC         =        MOL WGT(HC) =      HEAT(UHC)   =
                                            NO           =   360  NO2         =

FLUE GAS      01   151171  070C   3     1   CO2          =  .142  O2          =  .C69  CO            =      N2          =
                                            SO2          =  1950  UHC         =        MOL WGT(HC) =      HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      01   151171  070C   3     1   CO2          =        C2          =        CO            =      N2          =
                                            SO2          =        UHC         =        MOL WGT(HC) =      HEAT(UHC)   =
                                            NO           =   395  NO2         =

FLUE GAS      01                  3     X   CO2          = .1180  O2          = .0780  CO            =      N2          =
                                            SO2          =        UHC         =        MOL WGT(HC) =      HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      06                  1     0   CC2          = .0765  O2          =        CO            =      N2          =
                                            SO2          =  1272  UHC         =        MOL WGT(HC) =      HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      06   151171  23C0   1     1   CC2          =        O2          =  .C39  CO            =      N2          =
                                            SO2          =  1950  UHC         =        MOL WGT(HC) =      HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      06   161171  0000   1     1   CO2          =        O2          =  .042  CO            =      N2          =
                                            SO2          =  1950  UHC         =        MOL WGT(HC) =      HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      06   161171  0100   1     1   CC2          =        O2          =  .044  CO            =      N2          =
                                            SO2          =  1905  UHC         =        MCL WGT(HC) =      HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      06   161171  C200   1     1   CO2          =        O2          =  .044  CO            =      N2          =
                                            SO2          =  1920  UHC         =        MCL WGT(HC) =      HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      06   161171  0300   1     1   CC2          =        O2          =  .045  CO            =      N2          =
                                            SO2          =  1950  UHC         =        MOL WGT(HC) =      HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      06   161171  0700   1     1   CO2          =        O2          =  .044  CO            =      N2          =
                                            SO2          =  2115  UHC         =        MOL WGT(HC) =      HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      06   161171  0800   1     1   CC2          =        C2          =  .044  CO            =      N2          =
                                            SO2          =  2190  UHC         =        MOL WGT(HC) =      HEAT(UHC)   =
                                            NO           =        NO2         =

FLUE GAS      06                  2     0   CO2          =        O2          =        CO            =      N2          =
                                            SO2          =        UHC         =        MOL WGT(HC) =      HEAT(UHC)   =
                                            NO           =   464  NO2         =
RECORD TYPE  TEST   DATE   TIME  LCC  METH

FLUE GAS      06                  2    X   CO2         = .1180  O2          = .0650  CO             =      N2           =
                                           SO2         =        UHC         =        MOL WGT(HC) =        HEAT(UHC)    =
                                           NO          =        NO2         =

FLUE GAS      06                  3    0   CO2         = .0905  O2          =        CO             =      N2           =
                                           SO2         =  1768  UHC         =        MOL WGT(HC) =        HEAT(UHC)    =
                                           NO          =   466  NO2         =

FLUE GAS      06   161171  0700   3    1   CO2         =  .138  O2          =  .067  CO             =      N2           =
                                           SO2         =  1905  UHC         =        MOL WGT(HC) =        HEAT(UHC)    =
                                           NO          =        NO2         =

FLUE GAS      06   161171  0700   3    1   CO2         =        O2          =        CO             =      N2           =
                                           SO2         =        UHC         =        MOL WGT(HC) =        HEAT(UHC)    =
                                           NO          =   285  NO2         =

FLUE GAS      06   161171  0800   3    1   CO2         =  .138  O2          =  .068  CO             =      N2           =
                                           SO2         =  1890  UHC         =        MOL WGT(HC) =        HEAT(UHC)    =
                                           NO          =        NO2         =

FLUE GAS      06   161171  0800   3    1   CO2         =        O2          =        CO             =      N2           =
                                           SO2         =        UHC         =        MOL WGT(HC) =        HEAT(UHC)    =
                                           NO          =   285  NO2         =

FLUE GAS      06                  3    X   CO2         = .1260  O2          = .0620  CO             =      N2           =
                                           SO2         =        UHC         =        MOL WGT(HC) =        HEAT(UHC)    =
                                           NO          =        NO2         =

FLUE GAS      18                  1    0   CO2         = .1055  O2          =        CO             =      N2           =
                                           SO2         =  1569  UHC         =        MOL WGT(HC) =        HEAT(UHC)    =
                                           NO          =        NO2         =

FLUE GAS      18   161171  2300   1    1   CO2         =        O2          =  .046  CO             =      N2           =
                                           SO2         =  1695  UHC         =        MOL WGT(HC) =        HEAT(UHC)    =
                                           NO          =        NO2         =

FLUE GAS      18   171171  0000   1    1   CO2         =        O2          =  .045  CO             =      N2           =
                                           SO2         =  1740  UHC         =        MOL WGT(HC) =        HEAT(UHC)    =
                                           NO          =        NO2         =

FLUE GAS      18   171171  0100   1    1   CO2         =        O2          =  .045  CO             =      N2           =
                                           SO2         =  1725  UHC         =        MOL WGT(HC) =        HEAT(UHC)    =
                                           NO          =        NO2         =

FLUE GAS      18   171171  0200   1    1   CO2         =        O2          =  .045  CO             =      N2           =
                                           SO2         =  1710  UHC         =        MOL WGT(HC) =        HEAT(UHC)    =
                                           NO          =        NO2         =

FLUE GAS      18   171171  0300   1    1   CO2         =        O2          =  .046  CO             =      N2           =
                                           SO2         =  1690  UHC         =        MOL WGT(HC) =        HEAT(UHC)    =
                                           NO          =        NO2         =

FLUE GAS      18   171171  0400   1    1   CO2         =        O2          =  .052  CO             =      N2           =
                                           SO2         =  1710  UHC         =        MOL WGT(HC) =        HEAT(UHC)    =
                                           NO          =        NO2         =
RECORD TYPE  TEST   CATE    TIME  LCC  METH

FLUE GAS      18   171171  050C    1     1   CO2      =         O2     =  .052  CO           =      N2          =
                                             SO2      =  1725   UHC    =        MOL WGT(HC)  =      HEAT(UHC)   =
                                             NO       =         NO2    =
FLUE GAS      18   171171  060C    1     1   CC2      =         C2     =  .C56  CC           =      N2          =
                                             SO2      =  1725   UHC    =        MOL WGT(HC)  =      HEAT(UHC)   =
                                             NO       =         NO2    =
FLUE GAS      18   171171  0700    1     1   CO2      =         O2     =  .050  CO           =      N2          =
                                             SO2      =  1725   UHC    =        MOL WGT(HC)  =      HEAT(UHC)   =
                                             NO       =         NO2    =
FLUE GAS      18                   2     0   CO2      =         O2     =        CC           =      N2          =
                                             SO2      =         UHC    =        MOL WGT(HC)  =      HEAT(UHC)   =
                                             NO       =   365   NO2    =
FLUE GAS      18                   2     X   CO2      = .1025   C2     = .0900  CC           =      N2          =
                                             SO2      =         UHC    =        MOL WGT(HC)  =      HEAT(UHC)   =
                                             NO       =         NO2    =
FLUE GAS      18                   3     0   CC2      = .0485   O2     =        CO           =      N2          =
                                             SC2      =  1154   UHC    =        MOL WGT(HC)  =      HEAT(UHC)   =
                                             NO       =   627   NO2    =
FLUE GAS      18   171171  0300    3     1   CO2      =  .136   O2     =  .075  CC           =      N2          =
                                             SC2      =  1455   UHC    =        MOL WGT(HC)  =      HEAT(UHC)   =
                                             NO       =         NO2    =
FLUE GAS      18   171171  0300    3     1   CO2      =         O2     =        CO           =      N2          =
                                             SO2      =         UHC    =        MOL WGT(HC)  =      HEAT(UHC)   =
                                             NO       =   365   NO2    =
FLUE GAS      18   171171  0400    3     1   CO2      =  .136   O2     =  .075  CO           =      N2          =
                                             SO2      =  1470   UHC    =        MOL WGT(HC)  =      HEAT(UHC)   =
                                             NO       =         NO2    =
FLUE GAS      18   171171  040C    3     1   CC2      =         O2     =        CO           =      N2          =
                                             SO2      =         UHC    =        MOL WGT(HC)  =      HEAT(UHC)   =
                                             NO       =   355   NO2    =
FLUE GAS      18   171171  050C    3     1   CO2      =  .136   O2     =  .074  CC           =      N2          =
                                             SO2      =  1500   UHC    =        MCL WGT(HC)  =      HEAT(UHC)   =
                                             NO       =         NO2    =
FLUE GAS      18   171171  050C    3     1   CO2      =         O2     =        CO           =      N2          =
                                             SO2      =         UHC    =        MOL WGT(HC)  =      HEAT(UHC)   =
                                             NO       =   360   NO2    =
FLUE GAS      18   171171  060C    3     1   CO2      =  .135   C2     =  .076  CO           =      N2          =
                                             SO2      =  1485   UHC    =        MOL WGT(HC)  =      HEAT(UHC)   =
                                             NO       =         NO2    =
FLUE GAS      18   171171  0600    3     1   CO2      =         O2     =        CO           =      N2          =
                                             SO2      =         UHC    =        MOL WGT(HC)  =      HEAT(UHC)   =
                                             NC       =   365   NO2    =
RECORD TYPE  TEST   CATE   TIME  LCC  METH

FLUE GAS      18  171171  07CC   3     1  CO2         =  .136  O2        =  .074  CO            =      N2           =
                                          SO2         =  1485  UHC       =        MOL WGT(HC)   =      HEAT(UHC)    =
                                          NC          =        NO2       =

FLUE GAS      18  171171  0700   3     1  CC2         =        O2        =        CC            =      N2           =
                                          SO2         =        UHC       =        MOL WGT(HC)   =      HEAT(UHC)    =
                                          NC          =   360  NO2       =

FLLE GAS      18                 3     X  CO2         = .1160  O2        = .0790  CO            =      N2           =
                                          SO2         =        UHC       =        MOL WGT(HC)   =      HEAT(UHC)    =
                                          NO          =        NO2       =

FLUE GAS      13                 1     0  CO2         = .0970  O2        =        CO            =      N2           =
                                          SO2         =  1848  UHC       =        MOL WGT(HC)   =      HEAT(UHC)    =
                                          NO          =        NO2       =

FLLE GAS      13  171171  2300   1     1  CO2         =        O2        =  .C65  CO            =      N2           =
                                          SO2         =  1560  UHC       =        MOL WGT(HC)   =      HEAT(UHC)    =
                                          NO          =        NO2       =

FLLE GAS      13  181171  C000   1     1  CC2         =        O2        =  .C68  CO            =      N2           =
                                          SC2         =  1680  UHC       =        MOL WGT(HC)   =      HEAT(UHC)    =
                                          NO          =        NO2       =

FLLE GAS      13  181171  0100   1     1  CC2         =        O2        =  .062  CO            =      N2           =
                                          SO2         =  1740  UHC       =        MOL WGT(HC)   =      HEAT(UHC)    =
                                          NO          =        NO2       =

FLLE GAS      13  181171  020C   1     1  CO2         =        O2        =  .C62  CC            =      N2           =
                                          SO2         =  1740  UHC       =        MOL WGT(HC)   =      HEAT(UHC)    =
                                          NC          =        NO2       =

FLUE GAS      13  181171  C300   1     1  CC2         =        O2        =  .063  CC            =      N2           =
                                          SO2         =  1680  UHC       =        MCL WGT(HC)   =      HEAT(UHC)    =
                                          NO          =        NO2       =

FLLE GAS      13  181171  C400   1     1  CC2         =        C2        =  .063  CC            =      N2           =
                                          SO2         =  1605  UHC       =        MCL WGT(HC)   =      HEAT(UHC)    =
                                          NC          =        NO2       =

FLLE GAS      13  181171  050C   1     1  CC2         =        C2        =        CO            =      N2           =
                                          SO2         =        UHC       =        MOL WGT(HC)   =      HEAT(UHC)    =
                                          NO          =        NO2       =

FLUE GAS      13  181171  C60C   1     1  CO2         =        C2        =  .C63  CC            =      N2           =
                                          SO2         =  1560  UHC       =        MOL WGT(HC)   =      HEAT(UHC)    =
                                          NO          =        NO2       =

FLLE GAS      13  181171  070C   1     1  CO2         =        C2        =  .062  CC            =      N2           =
                                          SO2         =  1500  UHC       =        MOL WGT(HC)   =      HEAT(UHC)    =
                                          NC          =        NO2       =

FLUE GAS      13                 2     0  CO2         =        O2        =        CO            =      N2           =
                                          SO2         =        UHC       =        MOL WGT(HC)   =      HEAT(UHC)    =
                                          NC          =   525  NO2       =
RECORD TYPE  TEST   CATE   TIME  LCC  METH

FLUE GAS      13                  2    X   CC2       = .0960  C2        = .1000  CC            =     N2          =
                                               SO2       =        UHC       =        MCL WGT(HC) =     HEAT(UHC)   =
                                               NO        =        NO2       =

FLUE GAS      13                  3    0   CO2       = .0370  02        =        CC            =     N2          =
                                               SO2       =   752  UHC       =        MOL WGT(HC) =     HEAT(UHC)   =
                                               KC        =   415  NO2       =

FLUE GAS      13   181171  0300   3    1   CO2       =  .128  02        =  .073  CO            =     N2          =
                                               SO2       =  1350  UHC       =        MOL WGT(HC) =     HEAT(UHC)   =
                                               NO        =        NO2       =

FLUE GAS      13   181171  0400   3    1   CO2       =  .128  C2        =  .C88  CO            =     N2          =
                                               SO2       =  1425  UHC       =        MOL WGT(HC) =     HEAT(UHC)   =
                                               NO        =        NO2       =

FLLE GAS      13   181171  0400   3    1   CC2       =        02        =        CO            =     N2          =
                                               SO2       =        UHC       =        MOL WGT(HC) =     HEAT(UHC)   =
                                               NO        =   335  NO2       =

FLUE GAS      13   181171  0500   3    1   CC2       =  .128  02        =  .087  CO            =     N2          =
                                               SC2       =  1380  UHC       =        MCL WGT(HC) =     HEAT(UHC)   =
                                               NO        =        NO2       =

FLUE GAS      13   181171  0500   3    1   CC2       =        02        =        CO            =     N2          =
                                               SO2       =        UHC       =        MOL WGT(HC) =     HEAT(UHC)   =
                                               NO        =   360  NO2       =

FLUE GAS      13   181171  060C   3    1   CO2       =  .128  02        =  .C87  CO            =     N2          =
                                               SO2       =  1365  UHC       =        MOL WGT(HC) =     HEAT(UHC)   =
                                               NO        =        NO2       =

FLUE GAS      13   181171  060C   3    1   CO2       =        02        =        CC            =     N2          =
                                               SO2       =        UHC       =        MCL WGT(HC) =     HEAT(UHC)   =
                                               NO        =   355  NO2       =

FLLE GAS      13   181171  C70C   3    1   CO2       =  .128  02        =  .091  CO            =     N2          =
                                               SO2       =  1335  UHC       =        MOL WGT(HC) =     HEAT(UHC)   =
                                               NC        =        NO2       =

FLUE GAS      13   181171  070C   3    1   CO2       =        02        =        CC            =     N2          =
                                               SO2       =        UHC       =        MOL WGT(HC) =     HEAT(UHC)   =
                                               NO        =   340  NO2       =

FLUE GAS      13                  3    X   CO2       = .1040  02        = .0880  CC            =     N2          =
                                               SO2       =        UHC       =        MOL WGT(HC) =     HEAT(UHC)   =
                                               NO        =        NO2       =

FLUE GAS      04                  1    0   CO2       = .0895  02        =        CC            =     N2          =
                                               SO2       =  1996  UHC       =        MOL WGT(HC) =     HEAT(UHC)   =
                                               NO        =        NO2       =

FLLE GAS      04   191171  0000   1    1   CO2       =        02        =  .031  CO            =     N2          =
                                               SO2       =  2216  UHC       =        MOL WGT(HC) =     HEAT(UHC)   =
                                               NO        =        NO2       =
RECORD TYPE  TEST   DATE   TIME  LCC  METH

FLLE GAS      04   191171  0100   1     1   CO2      =         O2       =  .031  CO            =       N2          =
                                            SO2      =   2334  UHC      =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO       =         NO2      =

FLLE GAS      04   191171  0200   1     1   CC2      =         O2       =  .C31  CO            =       N2          =
                                            SO2      =   2334  UHC      =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO       =         NO2      =

FLUE GAS      04   191171  0300   1     1   CO2      =         O2       =  .030  CO            =       N2          =
                                            SO2      =   2394  UHC      =        MCL WGT(HC) =       HEAT(UHC)   =
                                            NO       =         NO2      =

FLUE GAS      04   191171  0400   1     1   CO2      =         O2       =  .029  CO            =       N2          =
                                            SO2      =   2355  UHC      =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO       =         NO2      =

FLUE GAS      04   191171  05CO   1     1   CC2      =         O2       =  .C29  CO            =       N2          =
                                            SO2      =   2325  UHC      =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO       =         NO2      =

FLLE GAS      04   191171  060C   1     1   CO2      =         O2       =  .028  CO            =       N2          =
                                            SO2      =   2250  UHC      =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO       =         NO2      =

FLUE GAS      04   191171  0700   1     1   CO2      =         O2       =  .030  CO            =       N2          =
                                            SO2      =   2250  UHC      =        MCL WGT(HC) =       HEAT(UHC)   =
                                            NO       =         NO2      =

FLUE GAS      04                  1     X   CC2      =  .1420  C2       = .0420  CC            =       N2          =
                                            SO2      =         UHC      =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO       =         NO2      =

FLUE GAS      04                  2     0   CO2      =         C2       =        CC            =       N2          =
                                            SO2      =         UHC      =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NC       =    352  NO2      =

FLUE GAS      04                  2     X   CC2      =  .1320  O2       = .0510  CC            =       N2          =
                                            SO2      =         UHC      =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO       =         NO2      =

FLLE GAS      04                  3     0   CO2      =  .0755  O2       =        CC            =       N2          =
                                            SO2      =   1918  UHC      =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NC       =    300  NO2      =

FLUE GAS      04   191171  0400   3     1   CO2      =         O2       =        CO            =       N2          =
                                            SO2      =         UHC      =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO       =    375  NO2      =

FLUE GAS      04   191171  0500   3     1   CO2      =   .142  O2       =  .062  CO            =       N2          =
                                            SO2      =   2130  UHC      =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO       =         NO2      =

FLUE GAS      04   191171  0500   3     1   CO2      =         O2       =        CO            =       N2          =
                                            SO2      =         UHC      =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NC       =    365  NO2      =
RECORD TYPE  TEST   DATE   TIPE  LCC  METH

FLLE GAS      04   191171  0600   3     1   CO2         = .142  O2         =         CO            =      N2          =
                                            SO2         = 2070  UHC        =         MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =       NO2        =

FLUE GAS      04   191171  0600   3     1   CC2         =       O2         =         CO            =      N2          =
                                            SO2         =       UHC        =         MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =  340  NO2        =

FLUE GAS      04   191171  0700   3     1   CO2         = .142  O2         = .062    CO            =      N2          =
                                            SO2           2040  UHC        =         MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =       NO2        =

FLUE GAS      04   191171  C700   3     1   CO2         =       O2         =         CO            =      N2          =
                                            SO2         =       UHC        =         MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =  325  NO2        =

FLUE GAS      04                  3     X   CO2         =.1310  C2         =.0470    CC            =      N2          =
                                            SO2         =       UHC        =         MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =       NO2        =

FLUE GAS      05                  1     0   CC2         =.0570  O2         =         CC            =      N2          =
                                            SO2         =  539  UHC        =         MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =       NO2        =

FLUE GAS      05   211171  2300   1     1   CC2         =       O2         = .C23    CC            =      N2          =
                                            SO2         =  210  UHC        =         MOL WGT(HC) =       HEAT(UHC)   =
                                            NC          =       NO2        =

FLUE GAS      05   221171  0000   1     1   CO2         =       O2         = .023    CO            =      N2          =
                                            SO2         =  210  UHC        =         MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =       NO2        =

FLLE GAS      05   221171  0100   1     1   CO2         =       O2         =         CO            =      N2          =
                                            SO2         =  420  UHC        =         MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =       NO2        =

FLLE GAS      05   221171  C700   1     1   CO2         =       O2         = .C23    CO            =      N2          =
                                            SO2         =  570  UHC        =         MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =       NO2        =

FLUE GAS      05                  2     0   CO2         =       O2         =         CO            =      N2          =
                                            SO2         =       UHC        =         MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =  333  NO2        =

FLUE GAS      05                  2     X   CC2         =.1080  O2         =.0580    CO            =      N2          =
                                            SO2         =       UHC        =         MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =       NO2        =

FLUE GAS      05                  3     0   CO2         =.0735  O2         =         CO            =      N2          =
                                            SO2         =  443  UHC        =         MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =  308  NO2        =

FLUE GAS      05   221171  0400   3     1   CO2         =       O2         =         CO            =      N2          =
                                            SO2         =       UHC        =         MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =  200  NO2        =
RECURD TYPE  TEST   DATE   TIME  LCC  METH

FLLE GAS      05   221171  0500   3     1   CO2         =  .124  O2          = .C29  CO           =       N2          =
                                            SO2         =   660  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLUE GAS      05   221171  0500   2     1   CC2         =        O2          =       CO           =      N2          =
                                            SO2         =        UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =   240  NU2         =

FLUE GAS      05   221171  0600   3     1   CC2         =        C2          =       CO           =      N2          =
                                            SO2         =   630  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLUE GAS      05   221171  C60C   3     1   CC2         =        O2          =       CO           =      N2          =
                                            SO2         =        UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =   200  NO2         =

FLUE GAS      05   221171  07CC   3     1   CO2         =  .124  C2          = .035  CC           =      N2          =
                                            SO2         =   600  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLUE GAS      05                  3     X   CC2         = .1030  C2          = .0650 CC           =      N2          =
                                            SO2         =        UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NC          =        NO2         =

FLLE GAS      10                  1     0   CO2         = .0765  O2          =       CO           =      N2          =
                                            SO2         =   562  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NC          =        NO2         =

FLLE GAS      10   231171  0000   1     1   CO2         =        C2          = .021  CO           =      N2          =
                                            SO2         =   375  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NC2         =

FLLE GAS      10   231171  C100   1     .   CO2         =        O2          = .C21  CO           =      N2          =
                                            SO2         =   360  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLLE GAS      10   231171  C200   1     1   CO2         =        O2          = .021  CO           =      N2          =
                                            SO2         =   360  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NC          =        NO2         =

FLLE GAS      10   231171  0300   1     1   CO2         =        O2          = .021  CO           =      N2          =
                                            SO2         =   375  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLUE GAS      10   231171  C400   1     1   CO2         =        O2          = .021  CO           =      N2          =
                                            SO2         =   375  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLLE GAS      10   231171  C60C   1     1   CO2         =        O2          = .019  CO           =      N2          =
                                            SO2         =   420  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =

FLUE GAS      10   231171  C700   1     1   CC2         =        O2          = .019  CO           =      N2          =
                                            SO2         =   450  UHC         =       MOL WGT(HC) =       HEAT(UHC)   =
                                            NO          =        NO2         =
RECORD TYPE  TEST   CATE    TIME  LCC  METH

FLUE GAS      10                    2    0   CO2       =        O2        =        CO             =      N2           =
                                                 SO2       =        UHC       =        MOL WGT(HC) =      HEAT(UHC)    =
                                                 NO        =   233  NO2       =

FLUE GAS      10                    2    X   CC2       = .0960  C2        = .0760  CC             =      N2           =
                                                 SO2       =        UHC       =        MOL WGT(HC) =      HEAT(UHC)    =
                                                 NC        =        NO2       =

FLUE GAS      10                    3    0   CO2       = .0300  C2        =        CC             =      N2           =
                                                 SO2       =   426  UHC       =        MOL WGT(HC) =      HEAT(UHC)    =
                                                 NO        =   315  NO2       =

FLLE GAS      10   231171  0200    3    1   CO2       =  .130  O2        =  .060  CC             =      N2           =
                                                 SO2       =   510  UHC       =        MCL WGT(HC) =      HEAT(UHC)    =
                                                 NO        =        NO2       =

FLLE GAS      10   231171  0300    3    1   CO2       =  .130  O2        =  .060  CC             =      N2           =
                                                 SO2       =   540  UHC       =        MOL WGT(HC) =      HEAT(UHC)    =
                                                 NC        =        NO2       =

FLLE GAS      10   231171  0300    3    1   CO2       =        O2        =        CO             =      N2           =
                                                 SO2       =        UHC       =        MOL WGT(HC) =      HEAT(UHC)    =
                                                 NO        =    85  NO2       =

FLLE GAS      10   231171  0400    3    1   CO2       =  .131  O2        =  .060  CO             =      N2           =
                                                 SO2       =        UHC       =        MOL WGT(HC) =      HEAT(UHC)    =
                                                 NO        =        NC2       =

FLUE GAS      10   231171  0400    3    1   CG2       =        O2        =        CO             =      N2           =
                                                 SO2       =        UHC       =        MOL WGT(HC) =      HEAT(UHC)    =
                                                 NC        =   100  NO2       =

FLUE GAS      10   231171  0500    3    1   CO2       =  .132  O2        =  .060  CO             =      N2           =
                                                 SC2       =        UHC       =        MOL WGT(HC) =      HEAT(UHC)    =
                                                 NO        =        NO2       =

FLUE GAS      10   231171  0500    3    1   CO2       =        O2        =        CO             =      N2           =
                                                 SO2       =        UHC       =        MOL WGT(HC) =      HEAT(UHC)    =
                                                 NO        =   100  NO2       =

FLLE GAS      10   231171  0600    3    1   CO2       =  .132  O2        =        CO             =      N2           =
                                                 SO2       =   585  UHC       =        MOL WGT(HC) =      HEAT(UHC)    =
                                                 NO        =        NO2       =

FLUE GAS      10   231171  0600    3    1   CO2       =        O2        =        CO             =      N2           =
                                                 SO2       =        UHC       =        MOL WGT(HC) =      HFAT(UHC)    =
                                                 NO        =   100  NO2       =

FLLE GAS      10   231171  C700    3    1   CO2       =  .132  O2        =  .060  CO             =      N2           =
                                                 SO2       =   510  UHC       =        MOL WGT(HC) =      HEAT(UHC)    =
                                                 NC        =        NO2       =

FLLE GAS      10   231171  C700    3    1   CO2       =        C2        =        CC             =      N2           =
                                                 SO2       =        UHC       =        MOL WGT(HC) =      HEAT(UHC)    =
                                                 NO        =   110  NO2       =
RECORD TYPE  TEST   CATE   TIPE  LCC  PETH

FLUE GAS      10                  3    X   CO2       = .0990  C2        = .0650  CC             =      N2             =
                                           SO2       =        UHC       =        MOL WGT(HC) =      HEAT(UHC)      =
                                           NC        =        NO2       =

FLUE GAS      20                  1    0   CO2       = .0880  O2        =        CC             =      N2             =
                                           SO2       =   547  UHC       =        MOL WGT(HC) =      HEAT(UHC)      =
                                           NO        =        NO2       =

FLUE GAS      20   241171  0000   1    1   CO2       =        O2        =  .030  CC             =      N2             =
                                           SO2       =   525  UHC       =        MOL WGT(HC) =      HEAT(UHC)      =
                                           NC        =        NO2       =

FLUE GAS      20   241171  0100   1    1   CO2       =        O2        =  .030  CO             =      N2             =
                                           SO2       =   465  UHC       =        MOL WGT(HC) =      HEAT(UHC)      =
                                           NO        =        NO2       =

FLLE GAS      20   241171  0200   1    1   CO2       =        O2        =  .C28  CO             =      N2             =
                                           SO2       =   480  UHC       =        MOL WGT(HC) =      HEAT(UHC)      =
                                           NO        =        NO2       =

FLLE GAS      20   241171  0300   1    1   CO2       =        O2        =  .030  CO             =      N2             =
                                           SO2       =   450  UHC       =        MOL WGT(HC) =      HEAT(UHC)      =
                                           NO        =        NO2       =

FLLE GAS      20   241171  0400   1    1   CO2       =        C2        =  .030  CO             =      N2             =
                                           SC2       =   450  UHC       =        MOL WGT(HC) =      HEAT(UHC)      =
                                           NO        =        NO2       =

FLLE GAS      20   241171  0500   1    1   CO2       =        O2        =  .032  CO             =      N2             =
                                           SO2       =   465  UHC       =        MOL WGT(HC) =      PEAT(UHC)      =
                                           NO        =        NO2       =

FLUE GAS      20   241171  C600   1    1   CO2       =        O2        =  .036  CO             =      N2             =
                                           SO2       =   468  UHC       =        MOL WGT(HC) =      HEAT(UHC)      =
                                           NO        =        NO2       =

FLUE GAS      20                  2    0   CO2       =        O2        =        CO             =      N2             =
                                           SO2       =        UHC       =        MOL WGT(HC) =      HEAT(UHC)      =
                                           NO        =   273  NO2       =

FLLE GAS      20                  2    X   CC2       = .1080  C2        = .0520  CC             =      N2             =
                                           SO2       =        UHC       =        MCL WGT(HC) =      HEAT(UHC)      =
                                           NO        =        NO2       =

FLUE GAS      20                  3    0   CO2       = .0340  O2        =        CC             =      N2             =
                                           SO2       =   386  UHC       =        MOL WGT(HC) =      HEAT(UHC)      =
                                           NO        =   248  NO2       =

FLUE GAS      20   241171  0300   3    1   CO2       =  .126  O2        =  .068  CC             =      N2             =
                                           SO2       =   510  UHC       =        MOL WGT(HC) =      PEAT(UHC)      =
                                           NO        =        NO2       =

FLUE GAS      20   241171  0300   3    1   CO2       =        C2        =        CC             =      N2             =
                                           SO2       =        UHC       =        MOL WGT(HC) =      HEAT(UHC)      =
                                           NO        =   150  NO2       =
RECORD TYPE  TEST   CATE   TIPE  LCC  PETH

FLUE GAS       20   241171  0400   3     1   CO2        =  .126  G2         =  .070  CO            =       N2          =
                                             SO2        =        UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                             NO         =        NO2        =

FLLE GAS       20   241171  0400   3     1   CO2        =        C2         =        CO            =       N2          =
                                             SO2        =        UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                             NO         =   140  NO2        =

FLUE GAS       20   241171  0500   3     1   CO2        =  .128  O2         =  .068  CC            =       N2          =
                                             SO2        =   555  UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                             NO         =        NO2        =

FLUE GAS       20   241171  0500   3     1   CO2        =        C2         =        CO            =       N2          =
                                             SO2        =        UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                             NO         =   135  NO2        =

FLUE GAS       20   241171  0600   3     1   CO2        =  .126  O2         =  .C73  CO            =       N2          =
                                             SO2        =   600  UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                             NC         =        NO2        =

FLUE GAS       20   241171  0600   3     1   CO2        =        O2         =        CO            =       N2          =
                                             SO2        =        UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                             NO         =   155  NO2        =

FLUE GAS       20   241171  0700   3     1   CO2        =  .126  O2         =  .074  CO            =       N2          =
                                             SO2        =   600  UHC        =        MCL WGT(HC) =       HEAT(UHC)   =
                                             NO         =        NO2        =

FLLE GAS       20   241171  C700   3     1   CC2        =        O2         =        CO            =       N2          =
                                             SO2        =        UHC        =        MCL WGT(HC) =       HEAT(UHC)   =
                                             NC         =   155  NO2        =

FLUE GAS       20                  3     X   CC2        = .1060  O2         = .0570  CO            =       N2          =
                                             SO2        =        UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                             NO         =        NO2        =

FLUE GAS       02                  1     0   CO2        = .1155  O2         =        CC            =       N2          =
                                             SO2        =  1813  UHC        =        MCL WGT(HC) =       HEAT(UHC)   =
                                             NO         =        NO2        =

FLUE GAS       02   301171  0000   1     1   CC2        =        O2         =  .042  CO            =       N2          =
                                             SO2        =  2025  UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                             NO         =        NO2        =

FLUE GAS       02   301171  0100   1     1   CO2        =        O2         =  .040  CC            =       N2          =
                                             SO2        =  2040  UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                             NO         =        NO2        =

FLUE GAS       02   301171  0200   1     1   CO2        =        O2         =  .040  CO            =       N2          =
                                             SO2        =  2040  UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                             NO         =        NO2        =

FLLE GAS       02   301171  0300   1     1   CO2        =        O2         =  .041  CC            =       N2          =
                                             SO2        =  1980  UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                             NO         =        NO2        =
RECORD TYPE  TEST   DATE   TIPE  LCC  METH

FLUE GAS      02   301171  C400   1    1   CO2       =         C2       =  .040  CO            =        N2          =
                                           SO2       =  1950   UHC      =        MOL WGT(HC) =        HEAT(UHC)   =
                                           NC        =         NO2      =

FLUE GAS      02   301171  0500   1    1   CO2       =         O2       =  .C39  CC            =        N2          =
                                           SO2       =  2010   UHC      =        MOL WGT(HC) =        HEAT(UHC)   =
                                           NO        =         NO2      =

FLLE GAS      02   301171  0600   1    1   CO2       =         O2       =  .C38  CO            =        N2          =
                                           SO2       =  1740   UHC      =        MOL WGT(HC) =        HEAT(UHC)   =
                                           NO        =         NO2      =

FLUE GAS      02   301171  070C   1    1   CO2       =         O2       =  .C38  CO            =        N2          =
                                           SO2       =  1725   UHC      =        MOL WGT(HC) =        HEAT(UHC)   =
                                           NO        =         NO2      =

FLUE GAS      02                  2    0   CO2       =         O2       =        CO            =        N2          =
                                           SO2       =         UHC      =        MOL WGT(HC) =        HEAT(UHC)   =
                                           NO        =   509   NO2      =

FLUE GAS      02                  2    X   CO2       = .1320   O2       = .0560  CO            =        N2          =
                                           SO2       =         UHC      =        MOL WGT(HC) =        HEAT(UHC)   =
                                           NO        =         NO2      =

FLUE GAS      02                  3    0   CO2       = .0910   O2       =        CO            =        N2          =
                                           SO2       =  1429   UHC      =        MOL WGT(HC) =        HEAT(UHC)   =
                                           NO        =   431   NO2      =

FLUE GAS      02   301171  C200   3    1   CO2       =  .138   O2       =  .064  CO            =        N2          =
                                           SO2       =  1740   UHC      =        MOL WGT(HC) =        HEAT(UHC)   =
                                           NO        =         NO2      =

FLLE GAS      02   301171  C200   3    1   CC2       =         O2       =        CO            =        N2          =
                                           SO2       =         UHC      =        MOL WGT(HC) =        HEAT(UHC)   =
                                           NC        =   336   NO2      =

FLUE GAS      02   301171  C300   3    1   CO2       =  .140   C2       =        CO            =        N2          =
                                           SO2       =         UHC      =        MOL WGT(HC) =        HEAT(UHC)   =
                                           NC        =         NO2      =

FLUE GAS      02   301171  C30C   3    1   CO2       =         C2       =        CO            =        N2          =
                                           SO2       =         UHC      =        MOL WGT(HC) =        HEAT(UHC)   =
                                           NO        =   345   NO2      =

FLUE GAS      02   301171  0400   3    1   CO2       =  .140   C2       =        CC            =        N2          =
                                           SO2       =         UHC      =        MOL WGT(HC) =        HEAT(LHC)   =
                                           NC        =         NO2      =

FLUE GAS      02   301171  040C   3    1   CO2       =         O2       =        CO            =        N2          =
                                           SO2       =         UHC      =        MOL WGT(HC) =        HEAT(UHC)   =
                                           NO        =   325   NO2      =

FLLE GAS      02   301171  0500   3    1   CO2       =  .140   O2       =  .060  CO            =        N2          =
                                           SO2       =         UHC      =        MOL WGT(HC) =        HEAT(UHC)   =
                                           NO        =         NO2      =
RECORD TYPE  TEST   DATE   TIPE  LCC  PETH

FLUE GAS      02  301171  05C0   3     1   CO2          =        O2          =        CC              =      N2           =
                                           SO2          =        UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO           =   340  NO2         =

FLLE GAS      02  301171  0600   3     1   CO2          = .140   C2          = .C60   CO              =      N2           =
                                           SO2          =        UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO           =        NO2         =

FLUE GAS      02  301171  0600   3     1   CO2          =        O2          =        CO              =      N2           =
                                           SO2          =        UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO           =   335  NO2         =

FLLE GAS      02  301171  0700   3     1   CO2          = .142   O2          = .062   CO              =      N2           =
                                           SO2          =        UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO           =        NO2         =

FLUE GAS      02  301171  0700   3     1   CO2          =        O2          =        CO              =      N2           =
                                           SO2          =        UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO           =   370  NO2         =

FLUE GAS      02                 3     X   CO2          = .1310  O2          = .0580  CO              =      N2           =
                                           SO2          =        UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO           =        NO2         =

FLUE GAS      03                 1     0   CC2          = .0855  O2          =        CC              -      N2           =
                                           SO2          = 1763   UHC         =        MOL WGT(HC) -          HEAT(UHC)    =
                                           NO           =        NO2         =

FLLE GAS      03  011271  000C   1     1   CO2          =        C2          = .054   CC              =      N2           =
                                           SO2          =  2160  UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO           =        NO2         =

FLUE GAS      03  011271  010C   1     1   CC2          =        O2          = .056   CC              =      N2           =
                                           SO2          =  2145  UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NC           =        NO2         =

FLUE GAS      03  011271  0200   1     1   CO2          =        O2          = .057   CO              =      N2           =
                                           SO2          =  2145  UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO           =        NO2         =

FLLE GAS      03  011271  030C   1     1   CO2          =        O2          = .056   CC              =      N2           =
                                           SO2          =  2145  UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO           =        NO2         =

FLUE GAS      03  011271  040C   1     1   CO2          =        C2          = .056   CO              =      N2           =
                                           SO2          =  2160  UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO           =        NO2         =

FLUE GAS      03  011271  050C   1     1   CO2          =        O2          = .C56   CO              =      N2           =
                                           SO2          =  2130  UHC         =        MUL WGT(HC) =          HEAT(UHC)    =
                                           NO           =        NO2         =

FLUE GAS      03  011271  0600   1     1   CO2          =        O2          = .056   CO              =      N2           =
                                           SO2          =  2130  UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO           =        NO2         =
RECORD TYPE  TEST   CATE   TIME  LCC  METH

FLLE GAS      03   011271  070C   1     1   CO2          =        O2           =  .056  CO            =       N2           =
                                            SO2          =  2115  UHC          =        MOL WGT(HC) =        HEAT(UHC)    =
                                            NO           =        NC2          =

FLLE GAS      03                  2     0   CO2          =        O2           =        CO            =       N2           =
                                            SO2          =        UHC          =        MCL WGT(HC) =        HFAT(UHC)    =
                                            NO           =   352  NO2          =

FLLE GAS      03                  2     X   CO2          = .1210  O2           = .0690  CO            =       N2           =
                                            SO2          =        UHC          =        MOL WGT(HC) =        HEAT(UHC)    =
                                            NO           =        NO2          =

FLUE GAS      03                  3     0   CO2          = .0435  O2           =        CO            =       N2           =
                                            SO2          =  1305  UHC          =        MOL WGT(HC) =        HEAT(UHC)    =
                                            NO           =   492  NO2          =

FLUE GAS      03   011271  040C   3     1   CO2          =  .132  O2           =  .082  CO            =       N2           =
                                            SO2          =  1905  UHC          =        MOL WGT(HC) =        HEAT(UHC)    =
                                            NO           =        NO2          =

FLUE GAS      03   011271  C40C   3     1   CC2          =        C2           =        CO            =       N2           =
                                            SO2          =        UHC          =        MOL WGT(HC) =        HEAT(UHC)    =
                                            NO           =   335  NO2          =

FLUE GAS      03   011271  050C   3     1   CC2          =  .132  C2           =  .081  CO            =       N2           =
                                            SO2          =        UHC          =        MOL WGT(HC) =        HEAT(UHC)    =
                                            NO           =        NO2          =

FLUE GAS      03   011271  C50C   3     1   CO2          =        O2           =        CC            =       N2           =
                                            SO2          =        UHC          =        MOL WGT(HC) =        HEAT(UHC)    =
                                            NC           =   340  NO2          =

FLUE GAS      03   011271  060C   3     1   CO2          =  .132  O2           =  .080  CO            =       N2           =
                                            SO2          =  1845  UHC          =        MOL WGT(HC) =        HEAT(UHC)    =
                                            NO           =        NO2          =

FLLE GAS      03   011271  060C   3     1   CO2          =        O2           =        CO            =       N2           =
                                            SO2          =        UHC          =        MOL WGT(HC) =        HEAT(UHC)    =
                                            NO           =   365  NC2          =

FLLE GAS      03   011271  070C   3     1   CO2          =  .132  O2           =  .080  CO            =       N2           =
                                            SO2          =        UHC          =        MOL WGT(HC) =        HEAT(UHC)    =
                                            NO           =        NO2          =

FLUE GAS      03   011271  0700   3     1   CO2          =        O2           =        CO            =       N2           =
                                            SC2          =        UHC          =        MCL WGT(HC) =        HEAT(UHC)    =
                                            NO           =   360  NO2          =

FLLE GAS      03                  3     X   CO2          = .1180  O2           = .0740  CO            =       N2           =
                                            SO2          =        UHC          =        MOL WGT(HC) =        HEAT(UHC)    =
                                            NC           =        NO2          =

FLUE GAS      17                  1     0   CO2          = .1075  O2           =        CO            =       N2           =
                                            SO2          =  1544  UHC          =        MOL WGT(HC) =        HEAT(UHC)    =
                                            NO           =        NO2          =
RECORD TYPE  TEST   DATE   TIME  LOC  METH

FLUE GAS      17   021271  0000   1     1   CO2  =         O2   =  .042  CO          =     N2         =
                                            SO2  =  2040   UHC  =        MOL WGT(HC) =     HEAT(UHC)  =
                                            NO   =         NO2  =

FLUE GAS      17   021271  0100   1     1   CO2  =         O2   =  .034  CO          =     N2         =
                                            SO2  =  2100   UHC  =        MOL WGT(HC) =     HEAT(UHC)  =
                                            NO   =         NO2  =

FLUE GAS      17   021271  0200   1     1   CO2  =         O2   =  .037  CO          =     N2         =
                                            SO2  =  2085   UHC  =        MOL WGT(HC) =     HEAT(UHC)  =
                                            NO   =         NO2  =

FLUE GAS      17   021271  0300   1     1   CO2  =         O2   =  .036  CO          =     N2         =
                                            SO2  =  2070   UHC  =        MOL WGT(HC) =     HEAT(UHC)  =
                                            NO   =         NO2  =

FLUE GAS      17   021271  0400   1     1   CO2  =         O2   =  .036  CO          =     N2         =
                                            SO2  =  2100   UHC  =        MOL WGT(HC) =     HEAT(UHC)  =
                                            NO   =         NO2  =

FLUE GAS      17   021271  0500   1     1   CO2  =         O2   =  .037  CO          =     N2         =
                                            SO2  =  2100   UHC  =        MOL WGT(HC) =     HEAT(UHC)  =
                                            NO   =         NO2  =

FLUE GAS      17   021271  0600   1     1   CO2  =         O2   =  .038  CO          =     N2         =
                                            SO2  =  2085   UHC  =        MOL WGT(HC) =     HEAT(UHC)  =
                                            NO   =         NO2  =

FLUE GAS      17   021271  0700   1     1   CO2  =         O2   =  .040  CO          =     N2         =
                                            SO2  =  2100   UHC  =        MOL WGT(HC) =     HEAT(UHC)  =
                                            NO   =         NO2  =

FLUE GAS      17                  2     0   CO2  =         O2   =        CO          =     N2         =
                                            SO2  =         UHC  =        MOL WGT(HC) =     HEAT(UHC)  =
                                            NO   =   344   NO2  =

FLUE GAS      17                  2     X   CO2  = .1280   O2   = .0600  CO          =     N2         =
                                            SO2  =         UHC  =        MOL WGT(HC) =     HEAT(UHC)  =
                                            NO   =         NO2  =

FLUE GAS      17                  3     0   CO2  = .0845   O2   =        CO          =     N2         =
                                            SO2  =         UHC  =        MOL WGT(HC) =     HEAT(UHC)  =
                                            NO   =   109   NO2  =

FLUE GAS      17   021271  0300   3     1   CO2  =  .134   O2   =  .073  CO          =     N2         =
                                            SO2  =  1950   UHC  =        MOL WGT(HC) =     HEAT(UHC)  =
                                            NO   =         NO2  =

FLUE GAS      17   021271  0400   3     1   CO2  =  .134   O2   =  .074  CO          =     N2         =
                                            SO2  =         UHC  =        MOL WGT(HC) =     HEAT(UHC)  =
                                            NO   =         NO2  =

FLUE GAS      17   021271  0500   3     1   CO2  =         O2   =        CO          =     N2         =
                                            SO2  =         UHC  =        MOL WGT(HC) =     HEAT(UHC)  =
                                            NO   =   340   NO2  =
RECORD TYPE  TEST   DATE   TIME  LCC  METH

FLUE GAS      17   021271  0500   3     1   CO2        =  .134  O2        =  .075  CO            =       N2          =
                                            SO2        =        UHC       =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO         =        NO2       =

FLUE GAS      17   021271  060C   3     1   CO2        =  .136  O2        =  .074  CO            =       N2          =
                                            SO2        =  2010  UHC       =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO         =        NO2       =

FLUE GAS      17   021271  06CC   3     1   CO2        =        O2        =        CC            =       N2          =
                                            SO2        =        UHC       =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO         =   340  NO2       =

FLUE GAS      17   021271  C700   3     1   CC2        =  .136  O2        =  .074  CO            =       N2          =
                                            SO2        =        UHC       =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO         =        NO2       =

FLUE GAS      17   021271  07CC   3     1   CC2        =        O2        =        CO            =       N2          =
                                            SO2        =        UHC       =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO         =   345  NO2       =

FLUE GAS      17                  3     X   CO2        = .1260  O2        = .0660  CC            =       N2          =
                                            SO2        =        UHC       =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO         =        NO2       =

FLUE GAS      19                  1     C   CO2        = .0775  C2        =        CO            =       N2          =
                                            SO2        =  1733  UHC       =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO         =        NO2       =

FLUE GAS      19   031271  C200   1     1   CO2        =        O2        =  .060  CC            =       N2          =
                                            SO2        =  1905  UHC       =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NC         =        NO2       =

FLUE GAS      19   031271  0300   1     1   CO2        =        C2        =  .060  CC            =       N2          =
                                            SO2        =  1890  UHC       =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO         =        NO2       =

FLUE GAS      19   031271  040C   1     1   CO2        =        O2        =  .C59  CO            =       N2          =
                                            SO2        =  1875  UHC       =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO         =        NO2       =

FLLE GAS      19   031271  050C   1     1   CO2        =        O2        =  .C59  CO            =       N2          =
                                            SO2        =  1890  UHC       =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO         =        NO2       =

FLUE GAS      19   031271  0600   1     1   CC2        =        O2        =  .058  CO            =       N2          =
                                            SO2        =  1905  UHC       =        MCL WGT(HC) =       HEAT(UHC)   =
                                            NO         =        NO2       =

FLUE GAS      19   031271  0700   1     1   CC2        =        O2        =  .060  CO            =       N2          =
                                            SO2        =  1920  UHC       =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO         =        NO2       =

FLUE GAS      19                  1     X   CO2        = .1280  O2        = .0620  CO            =       N2          =
                                            SO2        =        UHC       =        MOL WGT(HC) =       HEAT(UHC)   =
                                            NO         =        NO2       =
RECORD TYPE  TEST   DATE   TIME  LCC  METH

FLUE GAS      19                  2     0   CO2     =         O2     =         CO              =      N2          =
                                            SO2     =         UHC    =         MOL WGT(HC) =          HEAT(UHC)   =
                                            NO      =    394  NO2    =

FLUE GAS      19                  2     X   CO2     = .1090   O2     = .0840   CO              =      N2          =
                                            SO2     =         UHC    =         MCL WGT(HC) =          HEAT(UHC)   =
                                            NO      =         NO2    =

FLUE GAS      19                  2     0   CC2     = .0395   O2     =         LC              =      N2          =
                                            SO2     =   861   UHC    =         MOL WGT(HC) =          HEAT(UHC)   =
                                            NO      =   404   NO2    =

FLUE GAS      19        71        3     1   CO2     =  .126   C2     =  .086   CC              =      N2          =
                                            SO2     =  1815   UHC    =         MOL WGT(HC) =          HEAT(UHC)   =
                                            NO      =         NO2    =

FLUE GAS      19        71        3     1   CC2     =         C2     =         CO              =      N2          =
                                            SO2     =         UHC    =         MOL WGT(HC) =          HEAT(UHC)   =
                                            NO      =         NO2    =

FLUE GAS      19                  3     X   CO2     = .1040   O2     = .0880   CC              =      N2          =
                                            SO2     =         UHC    =         MOL WGT(HC) =          HEAT(UHL)   =
                                            NO      =         NO2    =

FLUE GAS      21                  1     0   CO2     = .0755   O2     =         CC              =      N2          =
                                            SC2     =  1415   UHC    =         MOL WGT(HC) =          HEAT(UHC)   =
                                            NO      =         NO2    =

FLUE GAS      21   041271  0100   1     1   CO2     =         O2     =  .C54   CO              =      N2          =
                                            SO2     =  1860   UHC    =         MOL WGT(HC) =          HEAT(UHC)   =
                                            NO      =         NO2    =

FLLE GAS      21   041271  C2CC   1     1   CO2     =         O2     =  .C54   CC              =      N2          =
                                            SO2     =  1875   UHC    =         MOL WGT(HC) =          HFAT(UHC)   =
                                            NO      =         NO2    =

FLUE GAS      21   041271  0300   1     1   CC2     =         O2     =  .054   CO              =      N2          =
                                            SO2     =  1860   UHC    =         MOL WGT(HC) =          HEAT(UHC)   =
                                            NO      =         NO2    =

FLLE GAS      21   041271  0400   1     1   CO2     =         O2     =  .C54   CO              =      N2          =
                                            SO2     =  1875   UHC    =         MOL WGT(HC) =          HFAT(UHC)   =
                                            NO      =         NO2    =

FLUE GAS      21   041271  C500   1     1   CO2     =         O2     =  .054   CO              =      N2          =
                                            SO2     =  1860   UHC    =         MOL WGT(HC) =          HEAT(UHC)   =
                                            NO      =         NO2    =

FLUE GAS      21   041271  0600   1     1   CO2     =         U2     =  .054   CO              =      N2          =
                                            SO2     =  1890   UHC    =         MOL WGT(HC) =          HEAT(UHC)   =
                                            NO      =         NO2    =

FLUE GAS      21   041271  070C   1     1   CC2     =         O2     =  .054   CO              =      N2          =
                                            SO2     =  1905   UHC    =         MCL WGT(HC) =          HEAT(UHC)   =
                                            NO      =         NO2    =
RECORD TYPE  TEST   CATE   TIME  LCC  METH

FLUE GAS      21               2     0   CO2          =         O2           =         CO            =        N2          =
                                         SO2          =         UHC          =         MOL WGT(HC) =          HEAT(UHC)   =
                                         NO           =    366  NO2          =

FLLE GAS      21               2     X   CO2          = .1100   C2           = .0740   CC            =        N2          =
                                         SO2          =         UHC          =         MCL WGT(HC) =          HEAT(UHC)   =
                                         NO           =         NO2          =

FLUE GAS      21               3     0   CO2          = .0565   C2           =         CO            =        N2          =
                                         SO2          =    451  UHC          =         MOL WGT(HC) =          HEAT(UHC)   =
                                         NO           =    322  NO2          =

FLLE GAS      21  041271  020C   3     1   CO2          =  .124   C2           =  .078   CO            =        N2          =
                                         SO2          =         UHC          =         MCL WGT(HC) =          HEAT(UHC)   =
                                         NC           =         NO2          =

FLUE GAS      21  041271  0300   3     1   CO2          =  .126   O2           =  .077   CC            =        N2          =
                                         SO2          =   1710  UHC          =         MCL WGT(HC) =          HEAT(UHC)   =
                                         NC           =         NO2          =

FLLE GAS      21  041271  0300   3     1   CO2          =         O2           =         CC            =        N2          =
                                         SO2          =         UHC          =         MOL WGT(HC) =          HEAT(UHC)   =
                                         NO           =    195  NO2          =

FLLE GAS      21  041271  040C   3     1   CO2          =  .126   C2           =  .C77   CO            =        N2          =
                                         SO2          =   1575  UHC          =         MOL WGT(HC) =          HEAT(UHC)   =
                                         NO           =         NO2          =

FLUE GAS      21  041271  0400   3     1   CC2          =         O2           =         CO            =        N2          =
                                         SO2          =         UHC          =         MOL WGT(HC) =          HEAT(UHC)   =
                                         NC           =    195  NO2          =

FLLE GAS      21  041271  C500   3     1   CO2          =  .124   O2           =  .C78   CC            =        N2          =
                                         SO2          =   1665  UHC          =         MOL WGT(HC) =          HEAT(UHC)   =
                                         NO           =         NO2          =

FLLE GAS      21  041271  0500   3     1   CC2          =         O2           =         CO            =        N2          =
                                         SO2          =         UHC          =         MOL WGT(HC) =          HEAT(UHC)   =
                                         NO           =    195  NO2          =

FLLE GAS      21  041271  CECC   3     1   CO2          =  .126   O2           =  .C78   CO            =        N2          =
                                         SO2          =   1710  UHC          =         MOL WGT(HC) =          HEAT(UHC)   =
                                         NO           =         NO2          =

FLUE GAS      21  041271  CECC   3     1   CO2          =         O2           =         CO            =        N2          =
                                         SO2          =         UHC          =         MOL WGT(HC) =          HEAT(UHC)   =
                                         NO           =    205  NO2          =

FLUE GAS      21  041271  C70C   3     1   CO2          =  .124   L2           =  .C78   CC            =        N2          =
                                         SO2          =   1740  UHC          =         MOL WGT(HC) =          HEAT(UHC)   =
                                         NO           =         NO2          =

FLUE GAS      21  041271  C70C   3     1   CO2          =         C2           =         CC            =        N2          =
                                         SO2          =         UHC          =         MOL WGT(HC) =          HEAT(UHC)   =
                                         NO           =    210  NO2          =
RECORD TYPE  TEST   CATE   TIME  LCC  METH

FLUE GAS      21                  3     X   CO2         = .1060  C2           = .0820  CC             =       N2          =
                                            SO2         =        UHC          =        MOL WGT(HC) =         HEAT(UHC)   =
                                            NO          =        NO2          =

FLUE GAS      14                  1     0   CO2         =        O2           =        CC             =       N2          =
                                            SO2         =        UHC          =        MOL WGT(HC) =         HEAT(UHC)   =
                                            NO          =        NO2          =

FLUE GAS      14   071271  0000   1     1   CC2         =        O2           =  .042  CC             =       N2          =
                                            SO2         =  1710  UHC          =        MOL WGT(HC) =         HEAT(UHC)   =
                                            NO          =        NO2          =

FLUE GAS      14   071271  0100   1     1   CO2         =        O2           =  .C36  CC             =       N2          =
                                            SO2         =  1725  UHC          =        MOL WGT(HC) =         HEAT(UHC)   =
                                            NO          =        NO2          =

FLLE GAS      14   071271  020C   1     1   CO2         =        O2           =  .037  CO             =       N2          =
                                            SO2         =  1710  UHC          =        MOL WGT(HC) =         HEAT(UHC)   =
                                            NO          =        NO2          =

FLLE GAS      14   071271  0300   1     1   CC2         =        O2           =  .C37  CO             =       N2          =
                                            SO2         =  1695  UHC          =        MOL WGT(HC) =         HEAT(UHC)   =
                                            NO          =        NO2          =

FLUE GAS      14   071271  040C   1     1   CO2         =        O2           =  .037  CO             =       N2          =
                                            SO2         =  1740  UHC          =        MOL WGT(HC) =         HEAT(UHC)   =
                                            NO          =        NO2          =

FLLE GAS      14   C71271  0500   1     1   CC2         =        O2           =  .036  CO             =       N2          =
                                            SO2         =  1770  UHC          =        MOL WGT(HC) =         HEAT(UHC)   =
                                            NO          =        NO2          =

FLLE GAS      14   071271  060C   1     1   CC2         =        O2           =  .C37  CO             =       N2          =
                                            SO2         =  1785  UHC          =        MOL WGT(HC) =         HEAT(UHC)   =
                                            NO          =        NO2          =

FLLE GAS      14   071271  070C   1     1   CO2         =        O2           =  .037  CO             =       N2          =
                                            SO2         =  1815  UHC          =        MOL WGT(HC) =         HEAT(UHC)   =
                                            NC          =        NO2          =

FLUE GAS      14                  2     0   CC2         =        O2           =        CO             =       N2          =
                                            SO2         =        UHC          =        MOL WGT(HC) =         HEAT(UHC)   =
                                            NO          =        NO2          =

FLUE GAS      14                  2     X   CO2         = .1220  C2           = .0660  CO             =       N2          =
                                            SO2         =        UHC          =        MOL WGT(HC) =         HEAT(UHC)   =
                                            NO          =        NO2          =

FLUE GAS      14                  3     0   CO2         =        C2           =        CO             =       N2          =
                                            SO2         =        UHC          =        MOL WGT(HC) =         HEAT(UHC)   =
                                            NO          =        NO2          =

FLUE GAS      14   071271  0100   3     1   CO2         =  .140  O2           =  .068  CO             =       N2          =
                                            SO2         =  1785  UHC          =        MOL WGT(HC) =         HEAT(UHC)   =
                                            NO          =        NO2          =
RECORD TYPE  TEST   DATE   TIME  LOC  METH

FLUE GAS      14   071271  0100   3     1  CO2         =         O2          =        CO              =       N2           =
                                           SO2         =         UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO          =   205   NO2         =

FLUE GAS      14   071271  0200   3     1  CO2         =  .142   O2          =  .072  CO              =       N2           =
                                           SO2         =  1725   UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO          =         NO2         =

FLUE GAS      14   071271  0200   3     1  CO2         =         O2          =        CO              =       N2
                                           SO2         =         UHC         =        MOL WGT(HC) =          HEAT(UHC)
                                           NO          =   200   NO2         =

FLUE GAS      14   071271  0300   3     1  CO2         =  .142   O2          =  .071  CO              =       N2           =
                                           SO2         =  1755   UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO          =         NO2         =

FLUE GAS      14   071271  0300   3     1  CO2         =         O2          =        CO              =       N2           =
                                           SO2         =         UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO          =   200   NO2         =

FLUE GAS      14   071271  0400   3     1  CO2         =  .140   O2          =  .071  CO              =       N2           =
                                           SO2         =  1785   UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO          =         NO2         =

FLUE GAS      14   071271  0400   3     1  CO2         =         O2          =        CO              =       N2           =
                                           SO2         =         UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO          =   195   NO2         =

FLUE GAS      14   071271  0500   3     1  CO2         =  .140   O2          =  .071  CO              =       N2           =
                                           SO2         =  1830   UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO          =         NO2         =

FLUE GAS      14   071271  0500   3     1  CO2         =         O2          =        CO              =       N2           =
                                           SO2         =         UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO          =   210   NO2         =

FLUE GAS      14   071271  0600   3     1  CO2         =  .142   O2          =  .070  CO              =       N2           =
                                           SO2         =  1815   UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO          =         NO2         =

FLUE GAS      14   071271  0600   3     1  CO2         =         O2          =        CO              =       N2           =
                                           SO2         =         UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO          =   205   NO2         =

FLUE GAS      14   071271  0700   3     1  CO2         =  .142   O2          =  .071  CO              =       N2           =
                                           SO2         =  1785   UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO          =         NO2         =

FLUE GAS      14   071271  0700   3     1  CO2         =         O2          =        CO              =       N2           =
                                           SO2         =         UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO          =   205   NO2         =

FLUE GAS      14                  3     X  CO2         = .1260   O2          = .0610  CO              =       N2           =
                                           SO2         =         UHC         =        MOL WGT(HC) =          HEAT(UHC)    =
                                           NO          =         NO2         =
RECORD TYPE  TEST   DATE   TIME  LOC  METH

FLUE GAS      15                   1    0  CO2        =        O2         =        CO              =       N2          =
                                           SO2        =        UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =        NO2        =

FLUE GAS      15  081271  0000     1    1  CO2        =        O2         =  .046  CO              =       N2          =
                                           SO2        =  2070  UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =        NO2        =

FLUE GAS      15  081271  0100     1    1  CO2        =        O2         =  .037  CO              =       N2          =
                                           SO2        =  2115  UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =        NO2        =

FLUE GAS      15  081271  0200     1    1  CO2        =        O2         =  .036  CO              =       N2          =
                                           SO2        =  2115  UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =        NO2        =

FLUE GAS      15  081271  0300     1    1  CO2        =        O2         =  .037  CO              =       N2          =
                                           SO2        =  2100  UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =        NO2        =

FLUE GAS      15  081271  0400     1    1  CO2        =        O2         =  .036  CO              =       N2          =
                                           SO2        =  2115  UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =        NO2        =

FLUE GAS      15  081271  0500     1    1  CO2        =        O2         =  .036  CO              =       N2          =
                                           SO2        =  2115  UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =        NO2        =

FLUE GAS      15  081271  0600     1    1  CO2        =        O2         =  .037  CO              =       N2          =
                                           SO2        =  2115  UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =        NO2        =

FLUE GAS      15  081271  0700     1    1  CO2        =        O2         =  .036  CO              =       N2          =
                                           SO2        =  2115  UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =        NO2        =

FLUE GAS      15                   2    0  CO2        =        O2         =        CO              =       N2          =
                                           SO2        =        UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =        NO2        =

FLUE GAS      15                   2    X  CO2        = .1220  O2         = .0660  CO              =       N2          =
                                           SO2        =        UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =        NO2        =

FLUE GAS      15                   3    0  CO2        =        O2         =        CO              =       N2          =
                                           SO2        =        UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =        NO2        =

FLUE GAS      15  081271  0100     3    1  CO2        =  .138  O2         =  .070  CO              =       N2          =
                                           SO2        =        UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =        NO2        =

FLUE GAS      15  081271  0100     3    1  CO2        =        O2         =        CO              =       N2          =
                                           SO2        =        UHC        =        MOL WGT(HC) =       HEAT(UHC)   =
                                           NO         =   275  NO2        =
RECORD TYPE  TEST   DATE   TIME  LCC  METH

FLUE GAS      15   C81271  020C   3    1   CO2          = .138  O2          = .069  CO            =      N2          =
                                           SO2          =       UHC         =       MOL WGT(HC) =        HEAT(UHC)   =
                                           NO           =       NO2         =

FLUE GAS      15   C81271  0200   3    1   CO2          =       O2          =       CO            =      N2          =
                                           SO2          =       UHC         =       MOL WGT(HC) =        HEAT(UHC)   =
                                           NO           =  265  NO2         =

FLUE GAS      15   C81271  030C   3    1   CO2          = .136  C2          =       CC            =      N2          =
                                           SO2          =       UHC         =       MOL WGT(HC) =        HEAT(UHC)   =
                                           NO           =       NO2         =

FLUE GAS      15   C81271  05CC   3    1   CO2          = .140  C2          =       CO            =      N2          =
                                           SO2          =       UHC         =       MOL WGT(HC) =        HEAT(UHC)   =
                                           NO           =       NO2         =

FLUE GAS      15   C81271  0500   3    1   CC2          =       O2          =       CC            =      N2          =
                                           SO2          =       UHC         =       MOL WGT(HC) =        HEAT(UHC)   =
                                           NO           =  240  NO2         =

FLUE GAS      15   081271  060C   3    1   CO2          =       O2          =       CC            =      N2          =
                                           SO2          =       UHC         =       MOL WGT(HC) =        HEAT(UHC)   =
                                           NO           =  235  NO2         =

FLUE GAS      15   C81271  0700   3    1   CO2          =       O2          =       CO            =      N2          =
                                           SO2          =       UHC         =       MOL WGT(HC) =        HEAT(UHC)   =
                                           NO           =  245  NO2         =

FLUE GAS      15                  3    X   CO2          = .1220 O2          = .0670 CC            =      N2          =
                                           SO2          =       UHC         =       MOL WGT(HC) =        HEAT(UHC)   =
                                           NO           =       NO2         =

FLUE GAS      22                  1    0   CO2          =       O2          =       CO            =      N2          =
                                           SO2          =       UHC         =       MCL WGT(HC) =        HEAT(UHC)   =
                                           NO           =       NO2         =

FLUE GAS      22   C91271  000C   1    1   CO2          =       O2          = .C42  CO            =      N2          =
                                           SO2          =  930  UHC         =       MCL WGT(HC) =        HEAT(UHC)   =
                                           NO           =       NO2         =

FLUE GAS      22   091271  010C   1    1   CC2          =       O2          = .C42  CO            =      N2          =
                                           SO2          =  855  UHC         =       MCL WGT(HC) =        HEAT(UHC)   =
                                           NO           =       NO2         =

FLUE GAS      22   C91271  020C   1    1   CC2          =       O2          = .042  CC            =      N2          =
                                           SO2          =  750  UHC         =       MCL WGT(HC) =        HEAT(UHC)   =
                                           NO           =       NO2         =

FLUE GAS      22   091271  C30C   1    1   CO2          =       C2          = .042  CO            =      N2          =
                                           SO2          =  750  UHC         =       MOL WGT(HC) =        HEAT(UHC)   =
                                           NC           =       NO2         =

FLUE GAS      22   091271  040C   1    1   CO2          =       C2          = .C42  CC            =      N2          =
                                           SO2          =  675  UHC         =       MOL WGT(HC) =        HEAT(UHC)   =
                                           NC           =       NO2         =
RECORD TYPE  TEST   DATE   TIME  LOC  METH

FLUE GAS      22   091271  0500   1     1   CO2          =          O2          =  .042  CO               =        N2          =
                                            SO2          =    600   UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                            NO           =          NO2         =

FLUE GAS      22   091271  0600   1     1   CO2          =          O2          =  .042  CO               =        N2          =
                                            SO2          =    630   UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                            NO           =          NO2         =

FLUE GAS      22   091271  0700   1     1   CO2          =          O2          =  .042  CO               =        N2          =
                                            SO2          =    690   UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                            NO           =          NO2         =

FLUE GAS      22                  2     0   CO2          =          O2          =        CO               =        N2          =
                                            SO2          =          UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                            NO           =          NO2         =

FLUE GAS      22                  2     X   CO2          =  .1310   O2          = .0560  CO               =        N2          =
                                            SO2          =          UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                            NO           =          NO2         =

FLUE GAS      22                  3     0   CO2          =          O2          =        CO               =        N2          =
                                            SO2          =          UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                            NO           =          NO2         =

FLUE GAS      22   091271  0100   3     1   CO2          =   .138   O2          =  .056  CO               =        N2          =
                                            SO2          =   1920   UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                            NO           =          NO2         =

FLUE GAS      22   091271  0200   3     1   CO2          =   .138   O2          =  .058  CO               =        N2          =
                                            SO2          =   2040   UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                            NO           =          NO2         =

FLUE GAS      22   091271  0300   3     1   CO2          =   .138   O2          =  .056  CO               =        N2          =
                                            SO2          =   2040   UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                            NO           =          NO2         =

FLUE GAS      22   091271  0400   3     1   CO2          =   .136   O2          =        CO               =        N2          =
                                            SO2          =   2040   UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                            NO           =          NO2         =

FLUE GAS      22   091271  0500   3     1   CO2          =   .134   O2          =        CO               =        N2          =
                                            SO2          =   2130   UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                            NO           =          NO2         =

FLUE GAS      22   091271  0600   3     1   CO2          =   .134   O2          =        CO               =        N2          =
                                            SO2          =          UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                            NO           =          NO2         =

FLUE GAS      22   091271  0700   3     1   CO2          =   .136   O2          =        CO               =        N2          =
                                            SO2          =          UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                            NO           =          NO2         =

FLUE GAS      22                  3     1   CO2          =          O2          =        CO               =        N2          =
                                            SO2          =          UHC         =        MOL WGT(HC) =          HEAT(UHC)   =
                                            NO           =    200   NO2         =
RECORD TYPE  TEST   DATE   TIME  LOC  METH

FLUE GAS      22                  3     X   CO2         = .1260  O2          = .0630  CO              =        N2          =
                                            SO2         =        UHC         =        MOL WGT(HC)     =        HEAT(UHC)   =
                                            NO          =        NO2         =

CONSUMPTION   11                            COAL        =  85.0  TEMP(FA)    =   150  GAS FLOW        =        GAS PRES    =
                                            GAS TEMP    =

CONSUMPTION   09                            COAL        =  83.5  TEMP(FA)    =   150  GAS FLOW        =        GAS PRES    =
                                            GAS TEMP    =

CONSUMPTION   08                            COAL        =  63.7  TEMP(FA)    =   150  GAS FLOW        =        GAS PRES    =
                                            GAS TEMP    =

CONSUMPTION   12                            COAL        =  83.9  TEMP(FA)    =   150  GAS FLOW        =        GAS PRES    =
                                            GAS TEMP    =

CONSUMPTION   07                            COAL        =  84.2  TEMP(FA)    =   150  GAS FLOW        =        GAS PRES    =
                                            GAS TEMP    =

CONSUMPTION   06                            COAL        =  90.1  TEMP(FA)    =   150  GAS FLOW        =        GAS PRES    =
                                            GAS TEMP    =

CONSUMPTION   01                            COAL        =  64.8  TEMP(FA)    =   150  GAS FLOW        =        GAS PRES    =
                                            GAS TEMP    =

CONSUMPTION   18                            COAL        =  48.3  TEMP(FA)    =   150  GAS FLOW        =        GAS PRES    =
                                            GAS TEMP    =

CONSUMPTION   13                            COAL        =  32.3  TEMP(FA)    =   150  GAS FLOW        =        GAS PRES    =
                                            GAS TEMP    =

CONSUMPTION   04                            COAL        =  63.2  TEMP(FA)    =   150  GAS FLOW        =        GAS PRES    =
                                            GAS TEMP    =

CONSUMPTION   05                            COAL        =  34.0  TEMP(FA)    =   150  GAS FLOW        =   252  GAS PRES    =  15.7
                                            GAS TEMP    =  64.0

CONSUMPTION   10                            COAL        =  46.4  TEMP(FA)    =   150  GAS FLOW        =   400  GAS PRES    =  16.3
                                            GAS TEMP    =  65.0

CONSUMPTION   20                            COAL        =  26.0  TEMP(FA)    =   150  GAS FLOW        =   374  GAS PRES    =  15.2
                                            GAS TEMP    =  66.9

CONSUMPTION   02                            COAL        =  66.2  TEMP(FA)    =   150  GAS FLOW        =        GAS PRES    =
                                            GAS TEMP    =

CONSUMPTION   03                            COAL        =  65.2  TEMP(FA)    =   150  GAS FLOW        =        GAS PRES    =
                                            GAS TEMP    =

CONSUMPTION   17                            COAL        =  45.4  TEMP(FA)    =   150  GAS FLOW                GAS PRES    =
                                            GAS TEMP    =

CONSUMPTION   19                            COAL        =  50.5  TEMP(FA)    =   150  GAS FLOW        =        GAS PRES    =
                                            GAS TEMP    =
RECORD TYPE  TEST   DATE   TIME  LOC  METH

CONSUMPTION   21                       COAL        =  32.4  TEMP(FA)    =   150  GAS FLOW   =        GAS PRES    =
                                       GAS TEMP    =

CONSUMPTION   14                       COAL        =  47.0  TEMP(FA)    =   150  GAS FLOW   =        GAS PRES    =
                                       GAS TEMP    =

CONSUMPTION   15                       COAL        =  46.3  TEMP(FA)    =   150  GAS FLOW   =        GAS PRES    =
                                       GAS TEMP    =

CONSUMPTION   22                       COAL        =  63.2  TEMP(FA)    =   150  GAS FLOW   =        GAS PRES    =
                                       GAS TEMP    =

AIR HEATER    01   151171  0000     1  TEMP(AIR)   =   223  TEMP(GAS)   =   329
AIR HEATER    06   151171  2200     1  TEMP(AIR)   =   226  TEMP(GAS)   =   332
AIR HEATER    06   151171  2300     1  TEMP(AIR)   =   228  TEMP(GAS)   =   331
AIR HEATER    06   161171  0000     1  TEMP(AIR)   =   228  TEMP(GAS)   =   331
AIR HEATER    06   161171  0100     1  TEMP(AIR)   =   228  TEMP(GAS)   =   331
AIR HEATER    06   161171  0200     1  TEMP(AIR)   =   228  TEMP(GAS)   =   331
AIR HEATER    06   161171  0300     1  TEMP(AIR)   =   228  TEMP(GAS)   =   330
AIR HEATER    06   161171  0400     1  TEMP(AIR)   =   228  TEMP(GAS)   =   330
AIR HEATER    06   161171  0500     1  TEMP(AIR)   =   233  TEMP(GAS)   =   331
AIR HEATER    06   161171  0600     1  TEMP(AIR)   =   237  TEMP(GAS)   =   332
AIR HEATER    18   161171  2300     1  TEMP(AIR)   =        TEMP(GAS)   =
AIR HEATER    18   171171  0000     1  TEMP(AIR)   =   237  TEMP(GAS)   =   321
AIR HEATER    18   171171  0100     1  TEMP(AIR)   =   237  TEMP(GAS)   =   320
AIR HEATER    18   171171  0200     1  TEMP(AIR)   =   236  TEMP(GAS)   =   320
AIR HEATER    18   171171  0300     1  TEMP(AIR)   =   236  TEMP(GAS)   =   320
AIR HEATER    18   171171  0400     1  TEMP(AIR)   =   236  TEMP(GAS)   =   320
AIR HEATER    18   171171  0500     1  TEMP(AIR)   =   236  TEMP(GAS)   =   320
AIR HEATER    18   171171  0600     1  TEMP(AIR)   =   237  TEMP(GAS)   =   319
AIR HEATER    13   171171  2300     1  TEMP(AIR)   =   240  TEMP(GAS)   =   316
AIR HEATER    13   181171  0000     1  TEMP(AIR)   =   240  TEMP(GAS)   =   316
AIR HEATER    13   181171  0100     1  TEMP(AIR)   =   242  TEMP(GAS)   =   316
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RECORD TYPE  TEST   DATE   TIME  LOC  METH

AIR HEATER    13   181171  0200          1   TEMP(AIR)   =   238  TEMP(GAS)   =   315
AIR HEATER    13   181171  0300          1   TEMP(AIR)   =   234  TEMP(GAS)   =   314
AIR HEATER    13   181171  0400          1   TEMP(AIR)   =   235  TEMP(GAS)   =   314
AIR HEATER    13   181171  0500          1   TEMP(AIR)   =   232  TEMP(GAS)   =   313
AIR HEATER    13   181171  0600          1   TEMP(AIR)   =   233  TEMP(GAS)   =   314
AIR HEATER    04   181171  2300          1   TEMP(AIR)   =   234  TEMP(GAS)   =   320
AIR HEATER    04   191171  0000          1   TEMP(AIR)   =   234  TEMP(GAS)   =   321
AIR HEATER    04   191171  0100          1   TEMP(AIR)   =   235  TEMP(GAS)   =   321
AIR HEATER    04   191171  0200          1   TEMP(AIR)   =   235  TEMP(GAS)   =   322
AIR HEATER    04   191171  0300          1   TEMP(AIR)   =   236  TEMP(GAS)   =   322
AIR HEATER    04   191171  0400          1   TEMP(AIR)   =   236  TEMP(GAS)   =   321
AIR HEATER    04   191171  0500          1   TEMP(AIR)   =   236  TEMP(GAS)   =   321
AIR HEATER    04   191171  0600          1   TEMP(AIR)   =   235  TEMP(GAS)   =   321
AIR HEATER    05   211171  2300          1   TEMP(AIR)   =   235  TEMP(GAS)   =   309
AIR HEATER    05   221171  0000          1   TEMP(AIR)   =   236  TEMP(GAS)   =   312
AIR HEATER    05   221171  0100          1   TEMP(AIR)   =   235  TEMP(GAS)   =   312
AIR HEATER    05   221171  0200          1   TEMP(AIR)   =   235  TEMP(GAS)   =   312
AIR HEATER    05   221171  0300          1   TEMP(AIR)   =   235  TEMP(GAS)   =   313
AIR HEATER    05   221171  0400          1   TEMP(AIR)   =   235  TEMP(GAS)   =   313
AIR HEATER    05   221171  0500          1   TEMP(AIR)   =   235  TEMP(GAS)   =   314
AIR HEATER    05   221171  0600          1   TEMP(AIR)   =   235  TEMP(GAS)   =   314
AIR HEATER    05   221171  0700          1   TEMP(AIR)   =   235  TEMP(GAS)   =   317
AIR HEATER    10   231171  0000          1   TEMP(AIR)   =   235  TEMP(GAS)   =   323
AIR HEATER    10   231171  0100          1   TEMP(AIR)   =   235  TEMP(GAS)   =   321
AIR HEATER    10   231171  0200          1   TEMP(AIR)   =   236  TEMP(GAS)   =   322
AIR HEATER    10   231171  0300          1   TEMP(AIR)   =   236  TEMP(GAS)   =   323
AIR HEATER    10   231171  0400          1   TEMP(AIR)   =   237  TEMP(GAS)   =   323
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RECORD TYPE  TEST   DATE    TIME  LOC  METH

AIR HEATER    10   231171  0500          1   TEMP(AIR)   =   236  TEMP(GAS)   =   323
AIR HEATER    10   231171  0600          1   TEMP(AIR)   =   236  TEMP(GAS)   =   323
AIR HEATER    10   231171  0700          1   TEMP(AIR)   =   234  TEMP(GAS)   =   324
AIR HEATER    20   241171  0000          1   TEMP(AIR)   =   234  TEMP(GAS)   =   306
AIR HEATER    20   241171  0100          1   TEMP(AIR)   =   234  TEMP(GAS)   =   306
AIR HEATER    20   241171  0200          1   TEMP(AIR)   =   234  TEMP(GAS)   =   306
AIR HEATER    20   241171  0300          1   TEMP(AIR)   =   234  TEMP(GAS)   =   306
AIR HEATER    20   241171  0400          1   TEMP(AIR)   =   234  TEMP(GAS)   =   306
AIR HEATER    20   241171  0500          1   TEMP(AIR)   =   234  TEMP(GAS)   =   306
AIR HEATER    20   241171  0600          1   TEMP(AIR)   =   234  TEMP(GAS)   =   306
AIR HEATER    20   241171  0700          1   TEMP(AIR)   =   234  TEMP(GAS)   =   306
AIR HEATER    02   291171  0230          1   TEMP(AIR)   =   233  TEMP(GAS)   =   323
AIR HEATER    02   301171  0000          1   TEMP(AIR)   =   233  TEMP(GAS)   =   323
AIR HEATER    02   301171  0100          1   TEMP(AIR)   =   233  TEMP(GAS)   =   323
AIR HEATER    02   301171  0200          1   TEMP(AIR)   =   233  TEMP(GAS)   =   324
AIR HEATER    02   301171  0300          1   TEMP(AIR)   =   233  TEMP(GAS)   =   325
AIR HEATER    02   301171  0400          1   TEMP(AIR)   =   233  TEMP(GAS)   =   326
AIR HEATER    02   301171  0500          1   TEMP(AIR)   =   233  TEMP(GAS)   =   326
AIR HEATER    02   301171  0600          1   TEMP(AIR)   =   234  TEMP(GAS)   =   326
AIR HEATER    02   301171  0700          1   TEMP(AIR)   =   234  TEMP(GAS)   =   327
AIR HEATER    03   301171  2300          1   TEMP(AIR)   =   234  TEMP(GAS)   =   327
AIR HEATER    03   011271  0000          1   TEMP(AIR)   =   234  TEMP(GAS)   =   327
AIR HEATER    03   011271  0100          1   TEMP(AIR)   =   234  TEMP(GAS)   =   327
AIR HEATER    03   011271  0200          1   TEMP(AIR)   =   234  TEMP(GAS)   =   327
AIR HEATER    03   011271  0300          1   TEMP(AIR)   =   234  TEMP(GAS)   =   327
AIR HEATER    03   011271  0400          1   TEMP(AIR)   =   234  TEMP(GAS)   =   327
AIR HEATER    03   011271  0500          1   TEMP(AIR)   =   234  TEMP(GAS)   =   327
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RECORD TYPE  TEST   DATE   TIME  LOC  METH

AIR HEATER    03   011271  0600        1   TEMP(AIR)   =   234  TEMP(GAS)   =   328
AIR HEATER    17   011271  2300        1   TEMP(AIR)   =   223  TEMP(GAS)   =   319
AIR HEATER    17   021271  0000        1   TEMP(AIR)   =   223  TEMP(GAS)   =   319
AIR HEATER    17   021271  0100        1   TEMP(AIR)   =   223  TEMP(GAS)   =   319
AIR HEATER    17   021271  0200        1   TEMP(AIR)   =   223  TEMP(GAS)   =   319
AIR HEATER    17   021271  0300        1   TEMP(AIR)   =   223  TEMP(GAS)   =   318
AIR HEATER    17   021271  0400        1   TEMP(AIR)   =   223  TEMP(GAS)   =   318
AIR HEATER    17   021271  0500        1   TEMP(AIR)   =   231  TEMP(GAS)   =   318
AIR HEATER    17   021271  0600        1   TEMP(AIR)   =   242  TEMP(GAS)   =   316
AIR HEATER    17   021271  0700        1   TEMP(AIR)   =   238  TEMP(GAS)   =   315
AIR HEATER    19   011271  2100        1   TEMP(AIR)   =   235  TEMP(GAS)   =   412
AIR HEATER    19   011271  2200        1   TEMP(AIR)   =   235  TEMP(GAS)   =   413
AIR HEATER    19   011271  2300        1   TEMP(AIR)   =   235  TEMP(GAS)   =   417
AIR HEATER    19   021271  0000        1   TEMP(AIR)   =   236  TEMP(GAS)   =   422
AIR HEATER    19   021271  0100        1   TEMP(AIR)   =   236  TEMP(GAS)   =   352
AIR HEATER    19   021271  0200        1   TEMP(AIR)   =   236  TEMP(GAS)   =   348
AIR HEATER    19   021271  0300        1   TEMP(AIR)   =   236  TEMP(GAS)   =   349
AIR HEATER    19   021271  0400        1   TEMP(AIR)   =   236  TEMP(GAS)   =   351
AIR HEATER    19   021271  0500        1   TEMP(AIR)   =   236  TEMP(GAS)   =   352
AIR HEATER    19   021271  0600        1   TEMP(AIR)   =   236  TEMP(GAS)   =   353
AIR HEATER    19   021271  0700        1   TEMP(AIR)   =   235  TEMP(GAS)   =   393
AIR HEATER    21   031271  2300        1   TEMP(AIR)   =   234  TEMP(GAS)   =   440
AIR HEATER    21   041271  0000        1   TEMP(AIR)   =   233  TEMP(GAS)   =   439
AIR HEATER    21   041271  0100        1   TEMP(AIR)   =   232  TEMP(GAS)   =   422
AIR HEATER    21   041271  0200        1   TEMP(AIR)   =   232  TEMP(GAS)   =   415
AIR HEATER    21   041271  0300        1   TEMP(AIR)   =   232  TEMP(GAS)   =   413
AIR HEATER    21   041271  0400        1   TEMP(AIR)   =   232  TEMP(GAS)   =   375
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RECORD TYPE  TEST   DATE   TIME  LOC  METH

AIR HEATER    21   041271  0500         1   TEMP(AIR)   =   232  TEMP(GAS)   =   336
AIR HEATER    21   041271  0600         1   TEMP(AIR)   =   232  TEMP(GAS)   =   335
AIR HEATER    21   041271  0700         1   TEMP(AIR)   =   234  TEMP(GAS)   =   339
AIR HEATER    14   061271  2300         1   TEMP(AIR)   =        TEMP(GAS)   =
AIR HEATER    14   071271  0000         1   TEMP(AIR)   =        TEMP(GAS)   =
AIR HEATER    14   071271  0100         1   TEMP(AIR)   =   233  TEMP(GAS)   =   420
AIR HEATER    14   071271  0200         1   TEMP(AIR)   =   217  TEMP(GAS)   =   399
AIR HEATER    14   071271  0300         1   TEMP(AIR)   =   199  TEMP(GAS)   =   391
AIR HEATER    14   071271  0400         1   TEMP(AIR)   =   199  TEMP(GAS)   =   388
AIR HEATER    14   071271  0500         1   TEMP(AIR)   =   216  TEMP(GAS)   =   388
AIR HEATER    14   071271  0600         1   TEMP(AIR)   =   232  TEMP(GAS)   =   391
AIR HEATER    14   071271  0700         1   TEMP(AIR)   =   235  TEMP(GAS)   =   393
AIR HEATER    15   081271  0000         1   TEMP(AIR)   =   237  TEMP(GAS)   =   385
AIR HEATER    15   081271  0100         1   TEMP(AIR)   =   237  TEMP(GAS)   =   385
AIR HEATER    15   081271  0200         1   TEMP(AIR)   =   237  TEMP(GAS)   =   396
AIR HEATER    15   081271  0300         1   TEMP(AIR)   =   242  TEMP(GAS)   =   355
AIR HEATER    15   081271  0400         1   TEMP(AIR)   =   257  TEMP(GAS)   =   332
AIR HEATER    15   081271  0500         1   TEMP(AIR)   =   257  TEMP(GAS)   =   377
AIR HEATER    15   081271  0600         1   TEMP(AIR)   =   257  TEMP(GAS)   =   370
AIR HEATER    15   081271  0700         1   TEMP(AIR)   =   263  TEMP(GAS)   =   367
AIR HEATER    22   091271  0000         1   TEMP(AIR)   =   312  TEMP(GAS)   =   406
AIR HEATER    22   091271  0100         1   TEMP(AIR)   =   319  TEMP(GAS)   =   400
AIR HEATER    22   091271  0200         1   TEMP(AIR)   =   322  TEMP(GAS)   =   397
AIR HEATER    22   091271  0300         1   TEMP(AIR)   =   320  TEMP(GAS)   =   398
AIR HEATER    22   091271  0400         1   TEMP(AIR)   =   322  TEMP(GAS)   =   398
AIR HEATER    22   091271  0500         1   TEMP(AIR)   =   322  TEMP(GAS)   =   399
AIR HEATER    11   081171  1400         2   TEMP(AIR)   =   162  TEMP(GAS)   =   300
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RECORD TYPE  TEST   DATE   TIME  LOC  METH

AIR HEATER    11   081171  1500           2   TEMP(AIR)   =   158  TEMP(GAS)   =   301
AIR HEATER    11   081171  1600           2   TEMP(AIR)   =   166  TEMP(GAS)   =   300
AIR HEATER    11   081171  1700           2   TEMP(AIR)   =   169  TEMP(GAS)   =   302
AIR HEATER    11   081171  1800           2   TEMP(AIR)   =   173  TEMP(GAS)   =   304
AIR HEATER    11   081171  1900           2   TEMP(AIR)   =   163  TEMP(GAS)   =   302
AIR HEATER    11   081171  2000           2   TEMP(AIR)   =   165  TEMP(GAS)   =   308
AIR HEATER    11   081171  2100           2   TEMP(AIR)   =   169  TEMP(GAS)   =   300
AIR HEATER    11   081171  2200           2   TEMP(AIR)   =   169  TEMP(GAS)   =   302
AIR HEATER    11   081171  2300           2   TEMP(AIR)   =   169  TEMP(GAS)   =   303
AIR HEATER    11   081171  0000           2   TEMP(AIR)   =   170  TEMP(GAS)   =   302
AIR HEATER    09   091171  0900           2   TEMP(AIR)   =   163  TEMP(GAS)   =   299
AIR HEATER    09   091171  1000           2   TEMP(AIR)   =   160  TEMP(GAS)   =   299
AIR HEATER    09   091171  1100           2   TEMP(AIR)   =   158  TEMP(GAS)   =   296
AIR HEATER    09   091171  1200           2   TEMP(AIR)   =   157  TEMP(GAS)   =   299
AIR HEATER    09   091171  1300           2   TEMP(AIR)   =   156  TEMP(GAS)   =   299
AIR HEATER    09   091171  1400           2   TEMP(AIR)   =   157  TEMP(GAS)   =   301
AIR HEATER    09   091171  1500           2   TEMP(AIR)   =   160  TEMP(GAS)   =   303
AIR HEATER    09   091171  1600           2   TEMP(AIR)   =   161  TEMP(GAS)   =   301
AIR HEATER    09   091171  1700           2   TEMP(AIR)   =   163  TEMP(GAS)   =   302
AIR HEATER    09   091171  1800           2   TEMP(AIR)   =   164  TEMP(GAS)   =   303
AIR HEATER    09   091171  1900           2   TEMP(AIR)   =   160  TEMP(GAS)   =   300
AIR HEATER    08   101071  0900           2   TEMP(AIR)   =   162  TEMP(GAS)   =   303
AIR HEATER    08   101071  1000           2   TEMP(AIR)   =   164  TEMP(GAS)   =   302
AIR HEATER    08   101071  1100           2   TEMP(AIR)   =   170  TEMP(GAS)   =   305
AIR HEATER    08   101071  1200           2   TEMP(AIR)   =   175  TEMP(GAS)   =   308
AIR HEATER    08   101071  1300           2   TEMP(AIR)   =   178  TEMP(GAS)   =   310
AIR HEATER    08   101071  1400           2   TEMP(AIR)   =   178  TEMP(GAS)   =   310
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RECORD TYPE  TEST   CATE   TIME  LCC  METH

AIR HEATER    08   101C71  150C          2   TEMP(AIR)   =   180  TEMP(GAS)   =   308
AIR HEATER    08   101071  1600          2   TEMP(AIR)   =   178  TEMP(GAS)   =   310
AIR HEATER    08   1C1071  1700          2   TEMP(AIR)   =   175  TEMP(GAS)   =   311
AIR HEATER    08   101C71  1ECC          2   TEMP(AIR)   =   176  TEMP(GAS)   =   313
AIR HEATER    12   111171  090C          2   TEMP(AIR)   =   173  TEMP(GAS)   =   303
AIR HEATER    12   111171  1000          2   TEMP(AIR)   =   175  TEMP(GAS)   =   306
AIR HEATER    12   111171  1100          2   TEMP(AIR)   =   170  TEMP(GAS)   =   304
AIR HEATER    12   111171  120C          2   TEMP(AIR)   =   170  TEMP(GAS)   =   306
AIR HEATER    12   111171  130C          2   TEMP(AIR)   =   174  TEMP(GAS)   =   307
AIR HEATER    12   111171  140C          2   TEMP(AIR)   =   173  TEMP(GAS)   =   309
AIR HEATER    12   111171  150C          2   TEMP(AIR)   =   175  TEMP(GAS)   =   310
AIR HEATER    12   111171  160C          2   TEMP(AIR)   =   175  TEMP(GAS)   =   309
AIR HEATER    12   111171  1700          2   TEMP(AIR)   =   180  TEMP(GAS)   =   310
AIR HEATER    12   111171  180C          2   TEMP(AIR)   =   175  TEMP(GAS)   =   310
AIR HEATER    07   121171  0900          2   TEMP(AIR)   =   164  TEMP(GAS)   =   305
AIR HEATER    07   121171  1000          2   TEMP(AIR)   =   172  TEMP(GAS)   =   310
AIR HEATER    07   121171  1100          2   TEMP(AIR)   =   175  TEMP(GAS)   =   310
AIR HEATER    07   121171  1200          2   TEMP(AIR)   =   178  TEMP(GAS)   =   311
AIR HEATER    07   121171  1300          2   TEMP(AIR)   =   182  TEMP(GAS)   =   312
AIR HEATER    07   121171  140C          2   TEMP(AIR)   =   185  TEMP(GAS)   =   311
AIR HEATER    07   121171  1500          2   TEMP(AIR)   =   178  TEMP(GAS)   =   313
AIR HEATER    07   121171  160C          2   TEMP(AIR)   =   177  TEMP(GAS)   =   316
AIR HEATER    07   121171  170C          2   TEMP(AIR)   =   176  TEMP(GAS)   =   312
AIR HEATER    01   141171  220C          2   TEMP(AIR)   =   158  TEMP(GAS)   =   315
AIR HEATER    01   141171  2300          2   TEMP(AIR)   =   159  TEMP(GAS)   =   312
AIR HEATER    01   151171  0000          2   TEMP(AIR)   =   159  TEMP(GAS)   =   311
AIR HEATER    01   151171  0100          2   TEMP(AIR)   =   157  TEMP(GAS)   =   310
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RECORD TYPE  TEST   DATE   TIME  LCC  METH

AIR HEATER    01   151171  0200         2  TEMP(AIR)   =   159  TEMP(GAS)   =   308
AIR HEATER    01   151171  0300         2  TEMP(AIR)   =   163  TEMP(GAS)   =   308
AIR HEATER    01   151171  0400         2  TEMP(AIR)   =   163  TEMP(GAS)   =   308
AIR HEATER    01   151171  0500         2  TEMP(AIR)   =   163  TEMP(GAS)   =   311
AIR HEATER    01   151171  0600         2  TEMP(AIR)   =   163  TEMP(GAS)   =   312
AIR HEATER    06   161171   200         2  TEMP(AIR)   =   163  TEMP(GAS)   =   314
AIR HEATER    06   161171  0300         2  TEMP(AIR)   =   161  TEMP(GAS)   =   313
AIR HEATER    06   161171  0400         2  TEMP(AIR)   =   160  TEMP(GAS)   =   308
AIR HEATER    06   161171  0500         2  TEMP(AIR)   =   160  TEMP(GAS)   =   322
AIR HEATER    06   161171  0600         2  TEMP(AIR)   =        TEMP(GAS)   =
AIR HEATER    18   161171  2300         2  TEMP(AIR)   =   181  TEMP(GAS)   =   305
AIR HEATER    18   171171  0000         2  TEMP(AIR)   =   175  TEMP(GAS)   =   300
AIR HEATER    18   171171  0100         2  TEMP(AIR)   =   165  TEMP(GAS)   =   301
AIR HEATER    18   171171  0200         2  TEMP(AIR)   =   147  TEMP(GAS)   =   302
AIR HEATER    18   171171  0300         2  TEMP(AIR)   =   166  TEMP(GAS)   =   290
AIR HEATER    18   171171  0400         2  TEMP(AIR)   =   169  TEMP(GAS)   =   296
AIR HEATER    18   171171  0500         2  TEMP(AIR)   =   168  TEMP(GAS)   =   296
AIR HEATER    18   171171  0600         2  TEMP(AIR)   =   167  TEMP(GAS)   =   297
AIR HEATER    18   171171  0700         2  TEMP(AIR)   =   161  TEMP(GAS)   =   300
AIR HEATER    13   181171  0000         2  TEMP(AIR)   =   207  TEMP(GAS)   =   299
AIR HEATER    13   181171  0100         2  TEMP(AIR)   =   200  TEMP(GAS)   =   292
AIR HEATER    13   181171  0200         2  TEMP(AIR)   =   199  TEMP(GAS)   =   291
AIR HEATER    13   181171  0300         2  TEMP(AIR)   =   199  TEMP(GAS)   =   295
AIR HEATER    13   181171  0400         2  TEMP(AIR)   =   201  TEMP(GAS)   =   286
AIR HEATER    13   181171  0500         2  TEMP(AIR)   =   203  TEMP(GAS)   =   288
AIR HEATER    13   181171  0600         2  TEMP(AIR)   =   222  TEMP(GAS)   =   288
AIR HEATER    13   181171  0700         2  TEMP(AIR)   =   202  TEMP(GAS)   =   288
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RECORD TYPE  TEST   CATE   TIPE  LCC  PETH

AIR HEATER    04   181171  2300          2   TEMP(AIR)   =   155  TEMP(GAS)   =   306
AIR HEATER    04   191171  0000          2   TEMP(AIR)   =   149  TEMP(GAS)   =   305
AIR HEATER    04   191171  0100          2   TEMP(AIR)   =   154  TEMP(GAS)   =   304
AIR HEATER    04   191171  0200          2   TEMP(AIR)   =   166  TEMP(GAS)   =   305
AIR HEATER    04   191171  0300          2   TEMP(AIR)   =        TEMP(GAS)   =
AIR HEATER    04   191171  0400              TEMP(AIR)   =        TEMP(GAS)   =
AIR HEATER    04   191171  0500              TEMP(AIR)   =        TEMP(GAS)   =
AIR HEATER    04   191171  0600              TEMP(AIR)   =   167  TEMP(GAS)   =   306
AIR HEATER    05   211171  2300          2   TEMP(AIR)   =   171  TEMP(GAS)   =   280
AIR HEATER    05   221171  0000          2   TEMP(AIR)   =   166  TEMP(GAS)   =   284
AIR HEATER    05   221171  0100          2   TEMP(AIR)   =   167  TEMP(GAS)   =   287
AIR HEATER    05   221171  0200          2   TEMP(AIR)   =   167  TEMP(GAS)   =   288
AIR HEATER    05   221171  0300          2   TEMP(AIR)   =   165  TEMP(GAS)   =   287
AIR HEATER    05   221171  0400          2   TEMP(AIR)   =   165  TEMP(GAS)   =   288
AIR HEATER    05   221171  0500          2   TEMP(AIR)   =   164  TEMP(GAS)   =   288
AIR HEATER    05   221171  0600          2   TEMP(AIR)   =   170  TEMP(GAS)   =   293
AIR HEATER    05   221171  0700          2   TEMP(AIR)   =   163  TEMP(GAS)   =   288
AIR HEATER    10   231171  0000          2   TEMP(AIR)   =   162  TEMP(GAS)   =   304
AIR HEATER    10   231171  0100          2   TEMP(AIR)   =   161  TEMP(GAS)   =   297
AIR HEATER    10   231171  0200          2   TEMP(AIR)   =   159  TEMP(GAS)   =   298
AIR HEATER    10   231171  0300          2   TEMP(AIR)   =   161  TEMP(GAS)   =   298
AIR HEATER    10   231171  0400          2   TEMP(AIR)   =   166  TEMP(GAS)   =   299
AIR HEATER    10   231171  0500          2   TEMP(AIR)   =   161  TEMP(GAS)   =   299
AIR HEATER    10   231171  0600          2   TEMP(AIR)   =   152  TEMP(GAS)   =   299
AIR HEATER    10   231171  0700          2   TEMP(AIR)   =   163  TEMP(GAS)   =   298
AIR HEATER    20   241171  0000          2   TEMP(AIR)   =   184  TEMP(GAS)   =   289
AIR HEATER    20   241171  0100          2   TEMP(AIR)   =   193  TEMP(GAS)   =   277
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RECORD TYPE  TEST   CATE   TIME  LCC  METH

AIR HEATER    20   241171  0200        2   TEMP(AIR)   =   202  TEMP(GAS)   =   276
AIR HEATER    20   241171  0300        2   TEMP(AIR)   =   197  TEMP(GAS)   =   276
AIR HEATER    20   241171  0400        2   TEMP(AIR)   =   193  TEMP(GAS)   =   277
AIR HEATER    20   241171  C500        2   TEMP(AIR)   =   196  TEMP(GAS)   =   276
AIR HEATER    20   241171  0600        2   TEMP(AIR)   =   196  TEMP(GAS)   =   276
AIR HEATER    20   241171  070C        2   TEMP(AIR)   =   185  TEMP(GAS)   =   282
AIR HEATER    02   301171  0000        2   TEMP(AIR)   =   162  TEMP(GAS)   =   295
AIR HEATER    02   301171  0100        2   TEMP(AIR)   =   168  TEMP(GAS)   =   297
AIR HEATER    02   301171  0200        2   TEMP(AIR)   =   167  TEMP(GAS)   =   299
AIR HEATER    02   301171  0300        2   TEMP(AIR)   =   167  TFMP(GAS)   =   299
AIR HEATER    02   301171  C400        2   TEMP(AIR)   =   172  TEMP(GAS)   =   306
AIR HEATER    02   301171  0500        2   TEMP(AIR)   =   169  TEMP(GAS)   =   302
AIR HEATER    02   301171  0600        2   TEMP(AIR)   =   168  TEMP(GAS)   =   310
AIR HEATER    02   301171  C7CC        2   TEMP(AIR)   =        TEMP(GAS)   =   302
AIR HEATER    03   301171  2300        2   TEMP(AIR)   =   157  TEMP(GAS)   =   291
AIR HEATER    03   011271  000C        2   TEMP(AIR)   =   159  TEMP(GAS)   =   298
AIR HEATER    03   011271  010C        2   TEMP(AIR)   =   156  TEMP(GAS)   =   291
AIR HEATER    03   011271  0200        2   TEMP(AIR)   =   152  TEMP(GAS)   =   290
AIR HEATER    03   011271  030C        2   TEMP(AIR)   =   158  TEMP(GAS)   =   297
AIR HEATER    03   011271  040C        2   TEMP(AIR)   =   158  TEMP(GAS)   =   298
AIR HEATER    03   011271  0500        2   TEMP(AIR)   =   162  TEMP(GAS)   =   299
AIR HEATER    03   011271  060C        2   TEMP(AIR)   =   163  TEMP(GAS)   =   299
AIR HEATER    03   011271  070C        2   TEMP(AIR)   =   165  TEMP(GAS)   =   299
AIR HEATER    17   011271  230C        2   TEMP(AIR)   =   185  TEMP(GAS)   =   297
AIR HEATER    17   021271  0000        2   TEMP(AIR)   =   177  TEMP(GAS)   =   295
AIR HEATER    17   021271  010C        2   TEMP(AIR)   =   159  TEMP(GAS)   =   295
AIR HEATER    17   021271  020C        2   TEMP(AIR)   =   156  TEMP(GAS)   =   294
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RECORD TYPE  TEST   DATE   TIME  LOC  METH

AIR HEATER    17   021271  0300         2   TEMP(AIR)   =   155  TEMP(GAS)   =   292
AIR HEATER    17   021271  0400         2   TEMP(AIR)   =   154  TEMP(GAS)   =   291
AIR HEATER    17   021271  0500         2   TEMP(AIR)   =   144  TEMP(GAS)   =   290
AIR HEATER    17   021271  0600         2   TEMP(AIR)   =   148  TEMP(GAS)   =   289
AIR HEATER    17   021271  0700         2   TEMP(AIR)   =   154  TEMP(GAS)   =   288
AIR HEATER    19   021271  2100         2   TEMP(AIR)   =   177  TEMP(GAS)   =   294
AIR HEATER    19   021271  2200         2   TEMP(AIR)   =   177  TEMP(GAS)   =   286
AIR HEATER    19   021271  2300         2   TEMP(AIR)   =   178  TEMP(GAS)   =   284
AIR HEATER    19   031271  0000         2   TEMP(AIR)   =   178  TEMP(GAS)   =   291
AIR HEATER    19   031271  0100         2   TEMP(AIR)   =   177  TEMP(GAS)   =   286
AIR HEATER    19   031271  0200         2   TEMP(AIR)   =   181  TEMP(GAS)   =   285
AIR HEATER    19   031271  0300         2   TEMP(AIR)   =   185  TEMP(GAS)   =   286
AIR HEATER    19   031271  0400         2   TEMP(AIR)   =   183  TEMP(GAS)   =   286
AIR HEATER    19   031271  0500         2   TEMP(AIR)   =   184  TEMP(GAS)   =   287
AIR HEATER    19   031271  0600         2   TEMP(AIR)   =   185  TEMP(GAS)   =   289
AIR HEATER    19   031271  0700         2   TEMP(AIR)   =   188  TEMP(GAS)   =   290
AIR HEATER    21   041271  0000         2   TEMP(AIR)   =   141  TEMP(GAS)   =   284
AIR HEATER    21   041271  0100         2   TEMP(AIR)   =   107  TEMP(GAS)   =   280
AIR HEATER    21   041271  0200         2   TEMP(AIR)   =   102  TEMP(GAS)   =   282
AIR HEATER    21   041271  0300         2   TEMP(AIR)   =   101  TEMP(GAS)   =   286
AIR HEATER    21   041271  0400         2   TEMP(AIR)   =   101  TEMP(GAS)   =   284
AIR HEATER    21   041271  0500         2   TEMP(AIR)   =    99  TEMP(GAS)   =   280
AIR HEATER    21   041271  0600         2   TEMP(AIR)   =   100  TEMP(GAS)   =   278
AIR HEATER    21   041271  0700         2   TEMP(AIR)   =    98  TEMP(GAS)   =   283
AIR HEATER    14   071271  0000         2   TEMP(AIR)   =   113  TEMP(GAS)   =   298
AIR HEATER    14   071271  0100         2   TEMP(AIR)   =   104  TEMP(GAS)   =   302
AIR HEATER    14   071271  0200         2   TEMP(AIR)   =   100  TEMP(GAS)   =   295
```

```
RECORD TYPE  TEST   DATE   TIME  LOC  METH

AIR HEATER    14   071271  0300        2   TEMP(AIR)   =    99  TEMP(GAS)   =   297
AIR HEATER    14   071271  0400        2   TEMP(AIR)   =    98  TEMP(GAS)   =   297
AIR HEATER    14   071271  0500        2   TEMP(AIR)   =    98  TEMP(GAS)   =   297
AIR HEATER    14   071271  0600        2   TEMP(AIR)   =    98  TEMP(GAS)   =   298
AIR HEATER    14   071271  0700        2   TEMP(AIR)   =    98  TEMP(GAS)   =   293
AIR HEATER    15   081271  0100        2   TEMP(AIR)   =   168  TEMP(GAS)   =   301
AIR HEATER    15   081271  0200        2   TEMP(AIR)   =   166  TEMP(GAS)   =   300
AIR HEATER    15   081271  0300        2   TEMP(AIR)   =   164  TEMP(GAS)   =   300
AIR HEATER    15   081271  0400        2   TEMP(AIR)   =   166  TEMP(GAS)   =   301
AIR HEATER    15   081271  0500        2   TEMP(AIR)   =   166  TEMP(GAS)   =   302
AIR HEATER    15   081271  0600        2   TEMP(AIR)   =   168  TEMP(GAS)   =   303
AIR HEATER    22   081271  2300        2   TEMP(AIR)   =   167  TEMP(GAS)   =   304
AIR HEATER    22   091271  0000        2   TEMP(AIR)   =   169  TEMP(GAS)   =   303
AIR HEATER    22   091271  0100        2   TEMP(AIR)   =   169  TEMP(GAS)   =   303
AIR HEATER    22   091271  0200        2   TEMP(AIR)   =   168  TEMP(GAS)   =   304
AIR HEATER    22   091271  0300        2   TEMP(AIR)   =   167  TEMP(GAS)   =   304
AIR HEATER    22   091271  0400        2   TEMP(AIR)   =   168  TEMP(GAS)   =   305
AIR HEATER    22   091271  0500        2   TEMP(AIR)   =   167  TEMP(GAS)   =   305
AMBIENT       09                       0   TEMP        =  78.6  REL HUMID   =   .43  PRESSURE    = 29.92
AMBIENT       08                       0   TEMP        =  86.2  REL HUMID   =   .31  PRESSURE    = 29.84
AMBIENT       12                       0   TEMP        =  88.3  REL HUMID   =   .29  PRESSURE    = 29.80
AMBIENT       07                       0   TEMP        =  93.5  REL HUMID   =   .30  PRESSURE    = 29.57
AMBIENT       01                       0   TEMP        =  89.9  REL HUMID   =   .45  PRESSURE    = 29.86
AMBIENT       06                       0   TEMP        =  95.6  REL HUMID   =   .32  PRESSURE    = 29.85
AMBIENT       18                       0   TEMP        =  84.7  REL HUMID   =   .37  PRESSURE    = 29.76
AMBIENT       13                       0   TEMP        =  87.5  REL HUMID   =   .39  PRESSURE    = 29.55
AMBIENT       04                       0   TEMP        =  78.1  REL HUMID   =   .30  PRESSURE    = 29.73
```

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RECORD TYPE  TEST   DATE   TIME  LOC  METH

AMBIENT       05                        0   TEMP         =  70.9  REL HUMID    =   .32  PRESSURE     = 29.90

AMBIENT       10                        0   TEMP         =  69.8  REL HUMID    =   .29  PRESSURE     = 29.91

AMBIENT       20                        0   TEMP         =  70.0  REL HUMID    =   .40  PRESSURE     = 29.85

AMBIENT       02                        0   TEMP         =  77.5  REL HUMID    =   .29  PRESSURE     = 29.68

AMBIENT       33                        0   TEMP         =  74.5  REL HUMID    =   .29  PRESSURE     = 30.10

AMBIENT       17                        0   TEMP         =  67.0  REL HUMID    =   .39  PRESSURE     = 30.27

AMBIENT       19                        0   TEMP         =  70.9  REL HUMID    =   .32  PRESSURE     = 30.01

AMBIENT       21                        0   TEMP         =  73.5  REL HUMID    =   .34  PRESSURE     = 29.81

AMBIENT       14                        0   TEMP         =  71.3  REL HUMID    =   .55  PRESSURE     = 29.44

AMBIENT       15                        0   TEMP         =  76.0  REL HUMID    =   .37  PRESSURE     = 29.63

AMBIENT       11                        0   TEMP         =  72.0  REL HUMID    =   .55  PRESSURE     = 29.88

AMBIENT       22                        0   TEMP         =  81.0  REL HUMID    =   .41  PRESSURE     = 29.22

ELECTRICAL    11                            PULV 1       =  67.0  PULV 2       =  67.4  PULV 3       =  64.8  PULV 4       =  65.4
                                            F. D. FAN 1 = 101.2  F. D. FAN 2 = 102.2  I. D. FAN 1 = 183.0  I. D. FAN 2 = 157.2

ELECTRICAL    39                            PULV 1       =  64.9  PULV 2       =  64.0  PULV 3       =  65.6  PULV 4       =  64.5
                                            F. D. FAN 1 =  94.8  F. D. FAN 2 = 101.6  I. D. FAN 1 = 177.1  I. D. FAN 2 = 141.1

ELECTRICAL    08                            PULV 1       =  68.9  PULV 2       =  68.9  PULV 3       =  64.0  PULV 4       =  65.6
                                            F. D. FAN 1 = 102.0  F. D. FAN 2 = 108.9  I. D. FAN 1 = 190.4  I. D. FAN 2 = 172.9

ELECTRICAL    12                            PULV 1       =  67.1  PULV 2       =  68.3  PULV 3       =  63.6  PULV 4       =  65.3
                                            F. D. FAN 1 =  97.7  F. D. FAN 2 =  90.9  I. D. FAN 1 = 194.1  I. D. FAN 2 = 155.6

ELECTRICAL    07                            PULV 1       =  67.3  PULV 2       =  67.6  PULV 3       =  63.7  PULV 4       =  64.3
                                            F. D. FAN 1 =  95.0  F. D. FAN 2 = 103.4  I. D. FAN 1 = 191.2  I. D. FAN 2 = 153.7

ELECTRICAL    06                            PULV 1       =  71.0  PULV 2       =  71.6  PULV 3       =  62.8  PULV 4       =  61.7
                                            F. D. FAN 1 =  99.2  F. D. FAN 2 = 105.8  I. D. FAN 1 = 184.0  I. D. FAN 2 = 172.5

ELECTRICAL    01                            PULV 1       =  60.1  PULV 2       =  61.5  PULV 3       =  57.7  PULV 4       =  57.0
                                            F. D. FAN 1 =  86.1  F. D. FAN 2 =  93.3  I. D. FAN 1 = 162.3  I. D. FAN 2 = 129.0

ELECTRICAL    18                            PULV 1       =  00.0  PULV 2       =  59.3  PULV 3       =  56.5  PULV 4       =  55.5
                                            F. D. FAN 1 =  79.0  F. D. FAN 2 =  84.5  I. D. FAN 1 = 109.0  I. D. FAN 2 =  44.5

ELECTRICAL    13                            PULV 1       =  00.0  PULV 2       =  00.0  PULV 3       =  57.3  PULV 4       =  58.3
                                            F. D. FAN 1 =  75.1  F. D. FAN 2 =  80.1  I. D. FAN 1 = [illegible]  I. D. FAN 2 =  54.8

ELECTRICAL    04                            PULV 1       =  57.8  PULV 2       =  61.4  PULV 3       =  57.5  PULV 4       =  59.0
                                            F. D. FAN 1 =  85.9  F. D. FAN 2 =  91.0  I. D. FAN 1 = 155.9  I. D. FAN 2 =  40.5
```

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RECORD TYPE  TEST   DATE   TIME  LOC  METH

ELECTRICAL    05                         PULV 1       =  60.0  PULV 2       =  60.3  PULV 3       =  00.0  PULV 4       =  00.0
                                         F. D. FAN 1 =  88.8  F. D. FAN 2 =  97.1  I. D. FAN 1 = 110.0  I. D. FAN 2 =  95.6

ELECTRICAL    10                         PULV 1       =  64.6  PULV 2       =  68.4  PULV 3       =  00.0  PULV 4       =  00.0
                                         F. D. FAN 1 = 100.0  F. D. FAN 2 = 110.0  I. D. FAN 1 = 150.0  I. D. FAN 2 = 137.1

ELECTRICAL    20                         PULV 1       =  81.4  PULV 2       =  67.5  PULV 3       =   8.8  PULV 4       =   5.8
                                         F. D. FAN 1 =  89.9  F. D. FAN 2 =  94.3  I. D. FAN 1 =  81.4  I. D. FAN 2 =  62.9

ELECTRICAL    02                         PULV 1       =  59.7  PULV 2       =  64.4  PULV 3       =  58.0  PULV 4       =  57.6
                                         F. D. FAN 1 =  90.0  F. D. FAN 2 =  95.3  I. D. FAN 1 = 125.0  I. D. FAN 2 = 110.0

ELECTRICAL    03                         PULV 1       =  58.0  PULV 2       =  60.6  PULV 3       =  60.3  PULV 4       =  60.3
                                         F. D. FAN 1 =  95.0  F. D. FAN 2 = 106.4  I. D. FAN 1 = 120.0  I. D. FAN 2 = 110.0

ELECTRICAL    17                         PULV 1       =  00.0  PULV 2       =  56.0  PULV 3       =  58.1  PULV 4       =  57.0
                                         F. D. FAN 1 =  74.3  F. D. FAN 2 =  77.4  I. D. FAN 1 =  96.4  I. D. FAN 2 =  76.4

ELECTRICAL    19                         PULV 1       =  00.0  PULV 2       =  56.9  PULV 3       =  58.8  PULV 4       =  57.7
                                         F. D. FAN 1 =  83.3  F. D. FAN 2 =  88.8  I. D. FAN 1 =  92.4  I. D. FAN 2 =  78.6

ELECTRICAL    21                         PULV 1       =  59.8  PULV 2       =  60.3  PULV 3       =  00.0  PULV 4       =  00.0
                                         F. D. FAN 1 =  76.8  F. D. FAN 2 =  77.7  I. D. FAN 1 =  77.8  I. D. FAN 2 =  50.8

ELECTRICAL    14                         PULV 1       =  00.0  PULV 2       =  57.0  PULV 3       =  55.3  PULV 4       =  56.1
                                         F. D. FAN 1 =  78.0  F. D. FAN 2 =  75.7  I. D. FAN 1 =  93.3  I. D. FAN 2 =  91.4

ELECTRICAL    15                         PULV 1       =  00.0  PULV 2       =  56.1  PULV 3       =  57.2  PULV 4       =  56.6
                                         F. D. FAN 1 =  79.7  F. D. FAN 2 =  84.2  I. D. FAN 1 =  78.0  I. D. FAN 2 =  57.0

ELECTRICAL    22                         PULV 1       =  59.6  PULV 2       =  59.9  PULV 3       =  57.0  PULV 4       =  56.1
                                         F. D. FAN 1 =  86.2  F. D. FAN 2 =  94.5  I. D. FAN 1 = 107.6  I. D. FAN 2 =  96.1

CONDITIONS    11                         STEAM FLOW  = 786.0

CONDITIONS    09                         STEAM FLOW  = 787.8

CONDITIONS    08                         STEAM FLOW  = 789.8

CONDITIONS    12                         STEAM FLOW  = 791.9

CONDITIONS    07                         STEAM FLOW  = 794.0

CONDITIONS    06                         STEAM FLOW  = 801.1

CONDITIONS    01                         STEAM FLOW  = 799.0

CONDITIONS    18                         STEAM FLOW  = 803.1

CONDITIONS    13                         STEAM FLOW  = 804.8

CONDITIONS    04                         STEAM FLOW  = 806.5

CONDITIONS    05                         STEAM FLOW  = 810.1
```

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RECORD TYPE  TEST   DATE   TIME  LOC  METH

CONDITIONS    10                        STEAM FLOW  = 812.1
CONDITIONS    20                        STEAM FLOW  = 813.1
CONDITIONS    02                        STEAM FLOW  = 825.3
CONDITIONS    03                        STEAM FLOW  = 827.1
CONDITIONS    17                        STEAM FLOW  = 828.8
CONDITIONS    19                        STEAM FLOW  = 830.2
CONDITIONS    21                        STEAM FLOW  = 831.9
CONDITIONS    14                        STEAM FLOW  = 835.8
CONDITIONS    15                        STEAM FLOW  = 837.5
CONDITIONS    22                        STEAM FLOW  = 839.2
```

APPENDIX D

STUDIES OF THE CHEMICAL STATE OF SULFUR ADSORBED ON SURFACES OF FLY ASH

APPENDIX D

STUDIES OF THE CHEMICAL STATE OF SULFUR ADSORBED ON SURFACES OF FLY ASH

DISCUSSION OF RESULTS OF PHOTOELECTRON SPECTRA OF ADSORBED SULFUR

The photoelectron spectrum of sulfur has two intense peaks which allow easy identification of the element. These arise from electrons being ejected from the 2p and 2s levels; they are referred to as the "S2p" and "S2s" peaks in spectra. Both peaks were found for the fly ash samples. Thus, there is not question that sulfur is present in high concentrations on the surfaces of all the specimens. The S2p peak is the more intense, allowing good statistics. Long counts were takne for this peak in order to get accurate binding energy measurements of electrons in the S2p state. It has been shown that chemical states of elements can be deduced from binding energy measurements.[1,2]

Figures D1-D10 show the 2p spectra of sulfur adsorbed on the specimens submitted. Figures D4-D10 include also a peak due to the ejection of electrons from the 2s electron level of silicon. The second peak in Figures D3-D10 will be called the Si 2s peak. The Si 2s peaks were measured simultaneously with the S2p peaks because it was convenient to do so at the spectrometer settings used. For all spectra shown in the report, the upper scale on the abscissa indicates binding energy. The lower scale indicates kinetic energy. The relationship between the two scales is:

KINETIC ENERGY = 1487 ev - BINDING ENERGY

This relationship is discussed more thoroughly in attached references.[1,2] Figures D11 and D12 show S2p spectra of sulfur in K_2SO_4 and $CsSO_4$, used as standards.

The first column of Table D1 lists binding energies measured from the peaks in Figures D1-D10. The second column lists binding energies of standard compounds K_2SO_4, $CaSO_4$, $FeSO_4$, $Fe(SO_4)_3$, S°, Na_2S. The binding energies for K_2SO_4 and $CaSO_4$ were measured in this laboratory. The rest were taken from literature.[1] It is seen that the binding energy of sulfur and the fly ash samples is too high to correspond to any valence state lower that +6. Also, there is a closer match to the binding energies of sulfates of polyvalent cations than to monovalent cations.

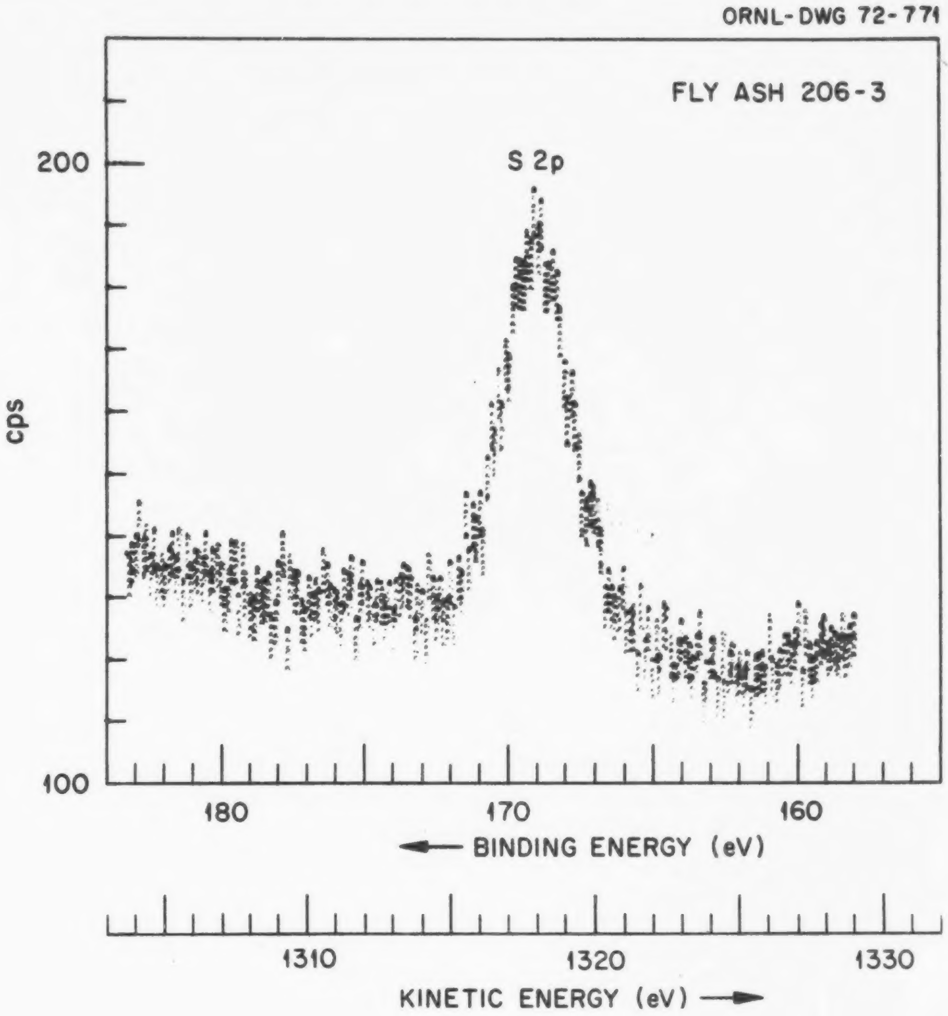
ORNL-DWG 72-771
FLY ASH 206-3
S 2p
200
100
cps
180
170
160
BINDING ENERGY (eV)
1310
1320
1330
KINETIC ENERGY (eV)

Figure D1

ORNL-DWG 72-759

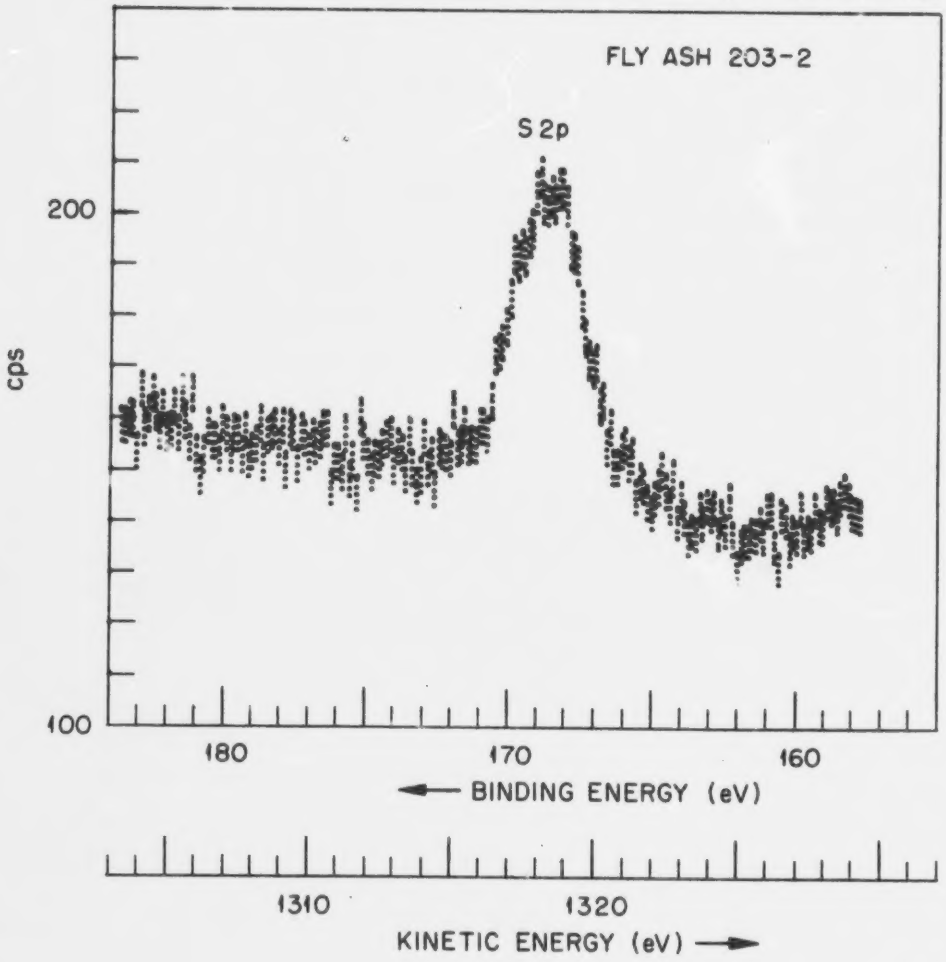

Figure D2

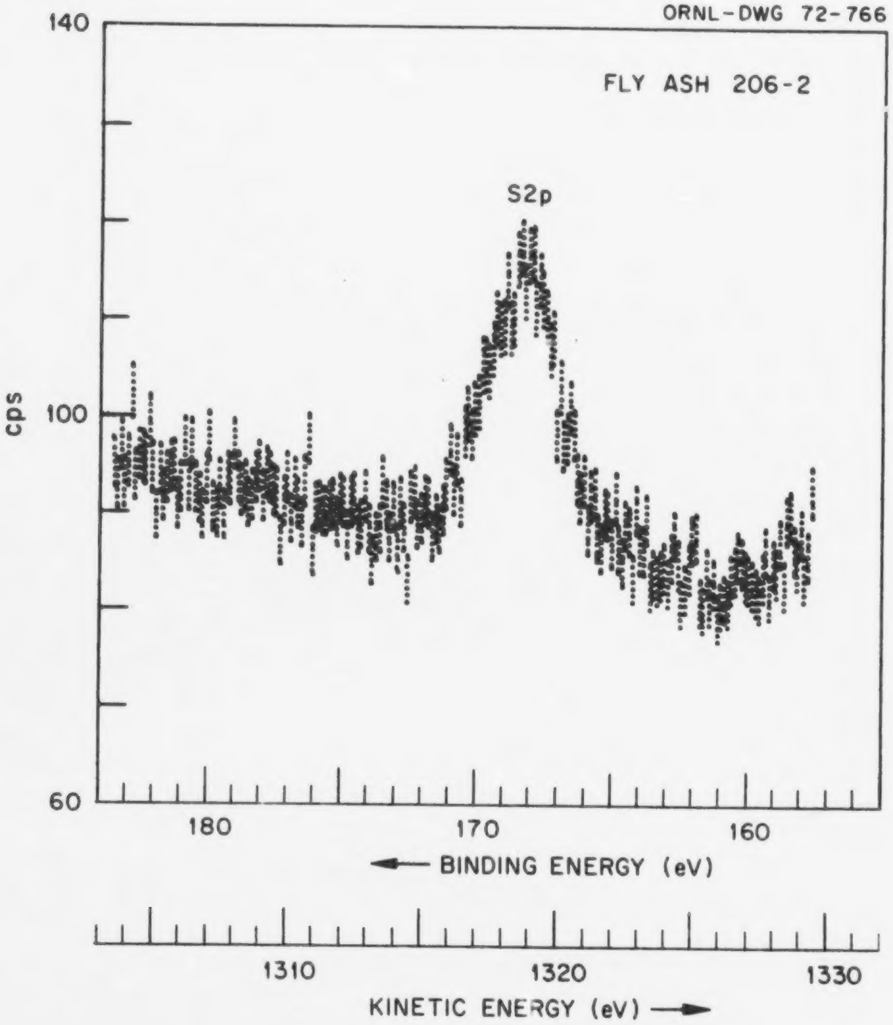
ORNL-DWG 72-766
FLY ASH 206-2
S2p
140
100
60
cps
180
170
160
← BINDING ENERGY (eV)
1310
1320
1330
KINETIC ENERGY (eV) →

Figure D3

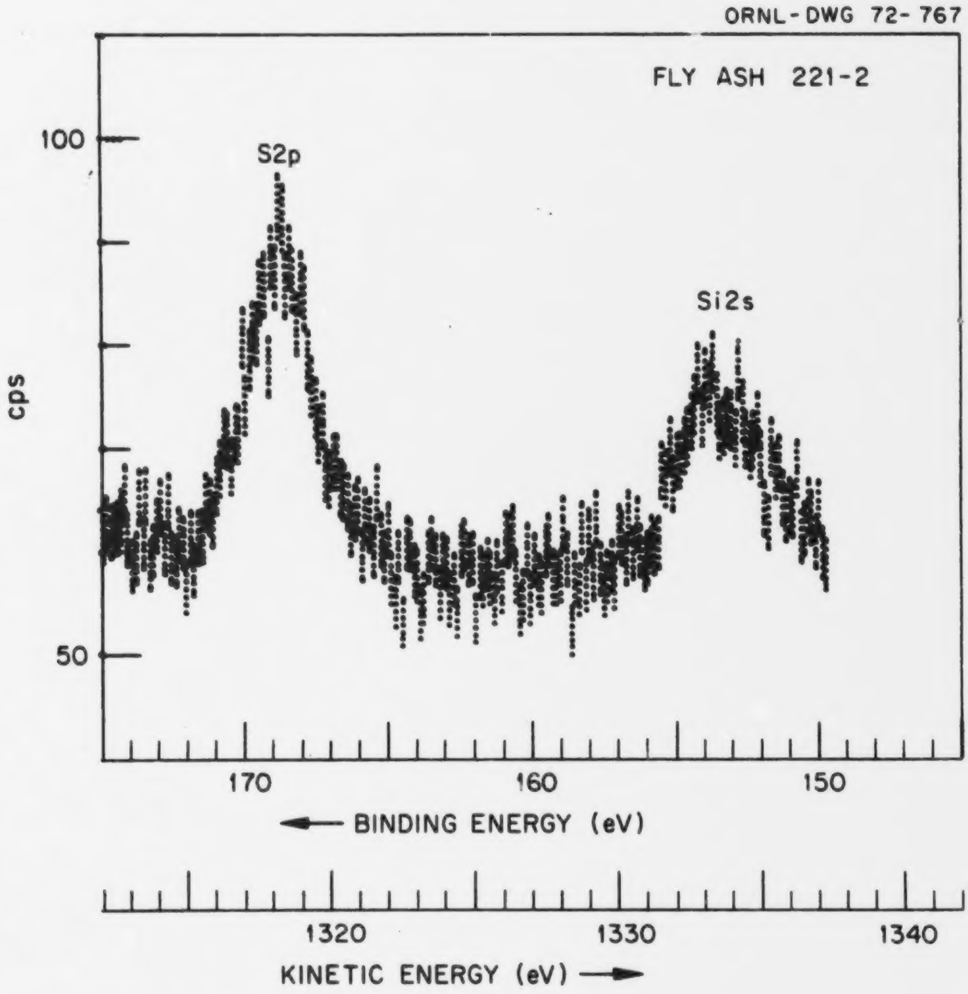
ORNL-DWG 72-767
FLY ASH 221-2
100
50
cps
S2p
Si2s
170
160
150
← BINDING ENERGY (eV)
1320
1330
1340
KINETIC ENERGY (eV) →

Figure D4

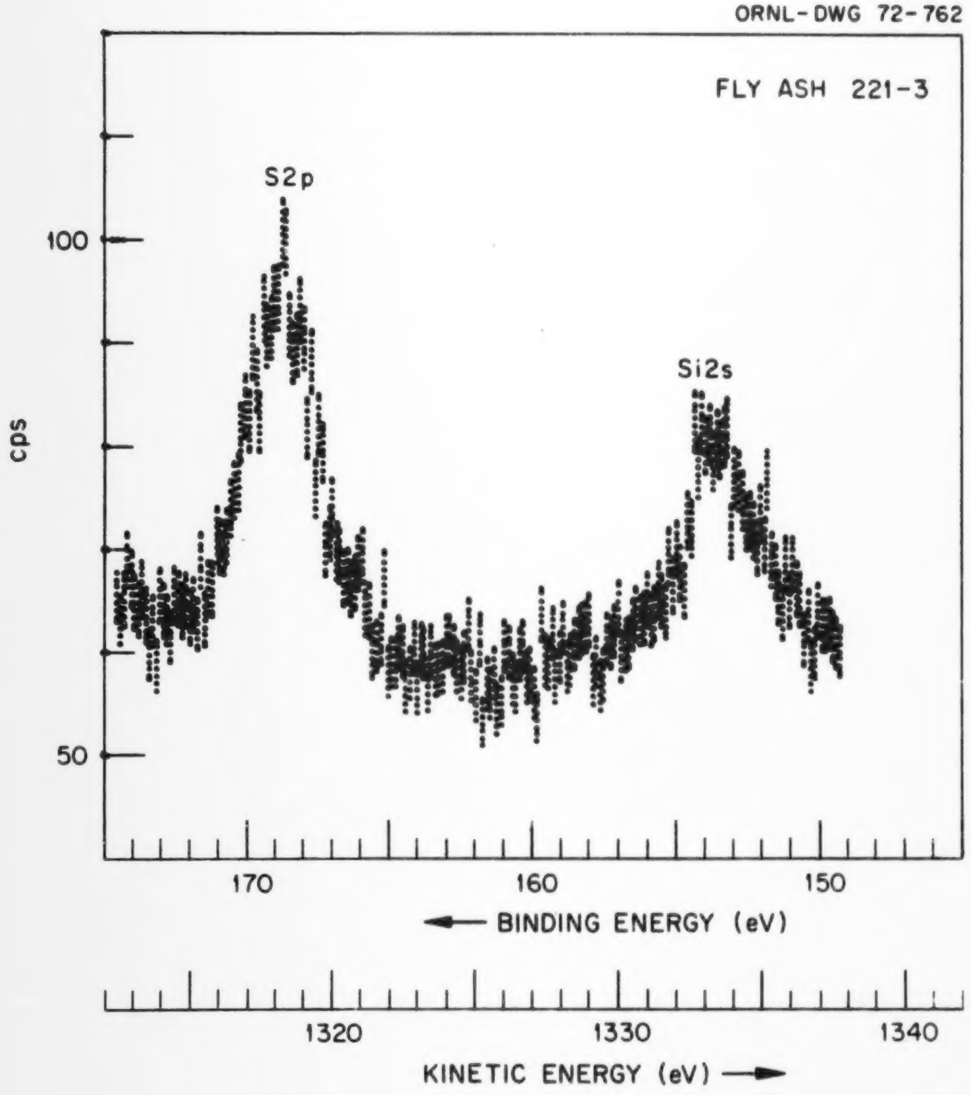
ORNL-DWG 72-762
FLY ASH 221-3
S2p
Si2s
cps
100
50
170
160
150
BINDING ENERGY (eV)
1320
1330
1340
KINETIC ENERGY (eV)

Figure D5

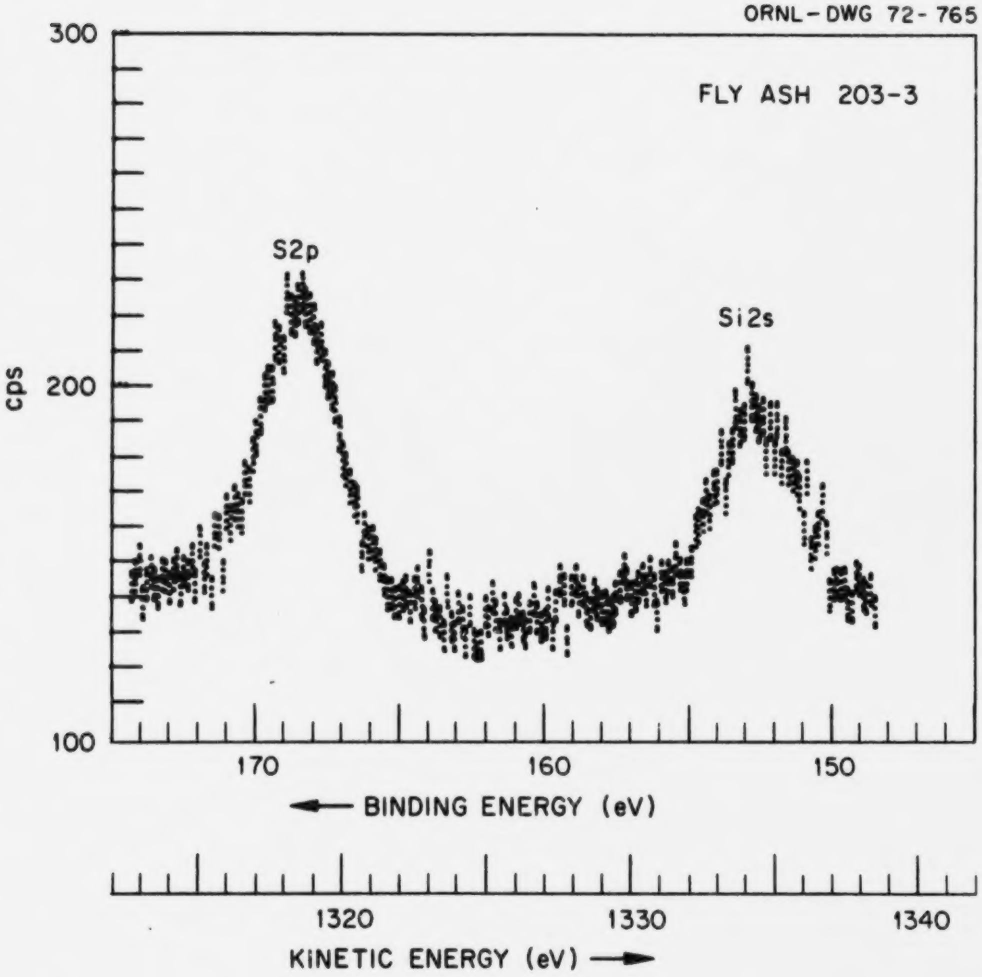
ORNL-DWG 72-765
FLY ASH 203-3
S2p
Si2s
cps
300
200
100
170
160
150
BINDING ENERGY (eV)
1320
1330
1340
KINETIC ENERGY (eV)

Figure D6

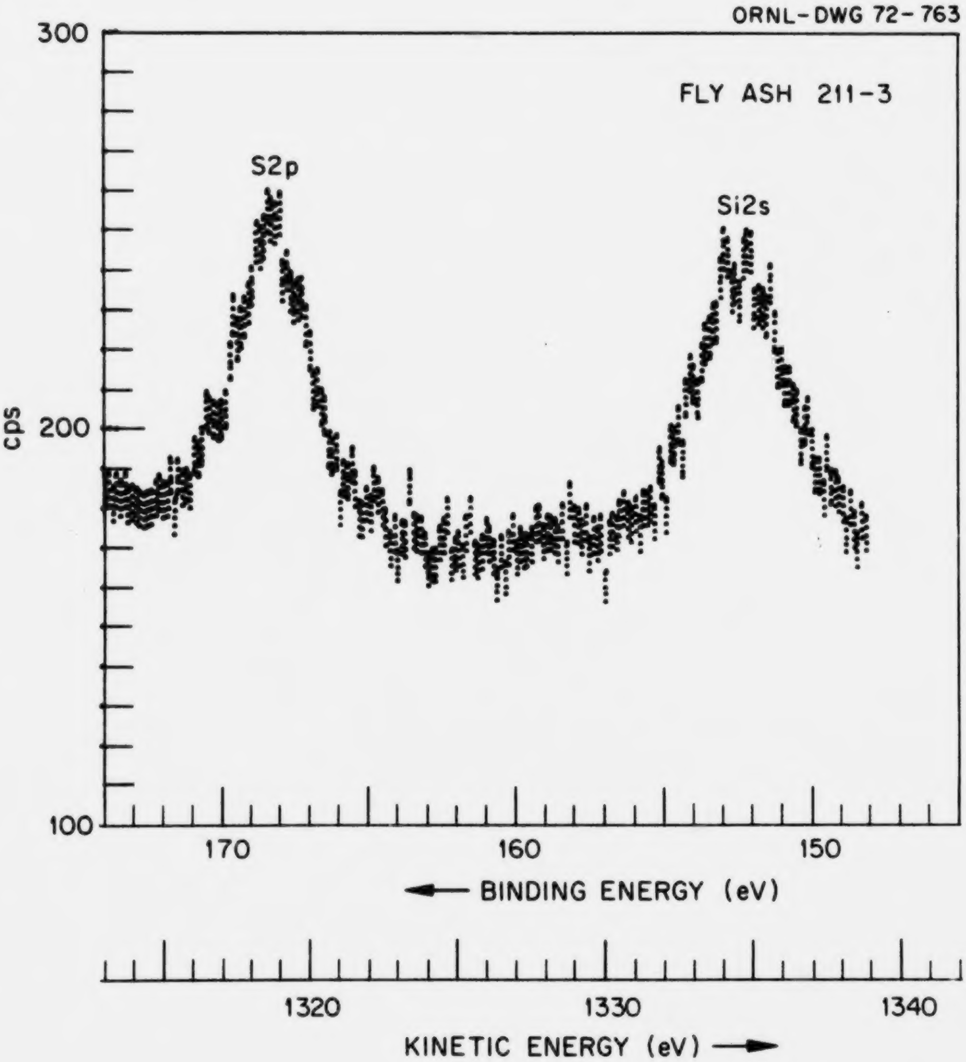
ORNL-DWG 72-763
FLY ASH 211-3
S2p
Si2s
cps
300
200
100
170
160
150
BINDING ENERGY (eV)
1320
1330
1340
KINETIC ENERGY (eV)

Figure D7

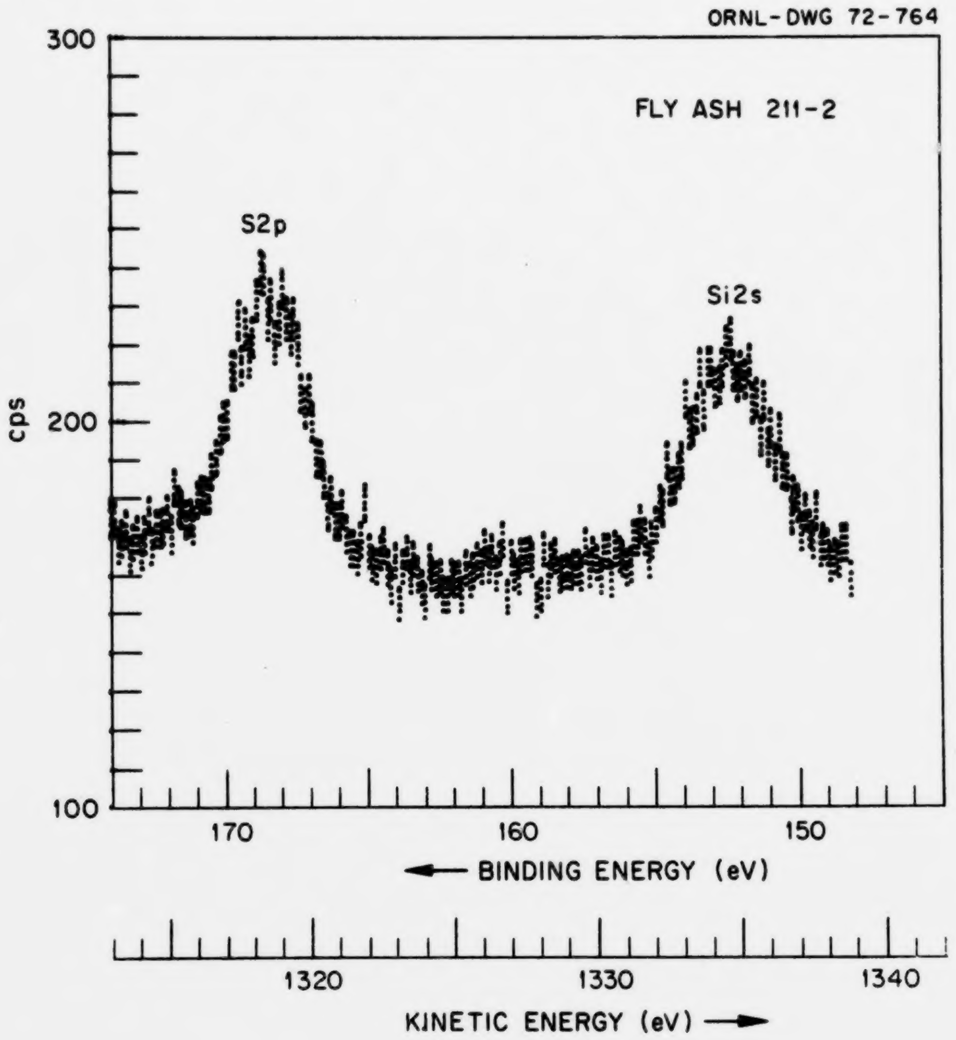
ORNL-DWG 72-764
FLY ASH 211-2
S2p
Si2s
cps
300
200
100
170
160
150
← BINDING ENERGY (eV)
1320
1330
1340
KINETIC ENERGY (eV) →

Figure D8

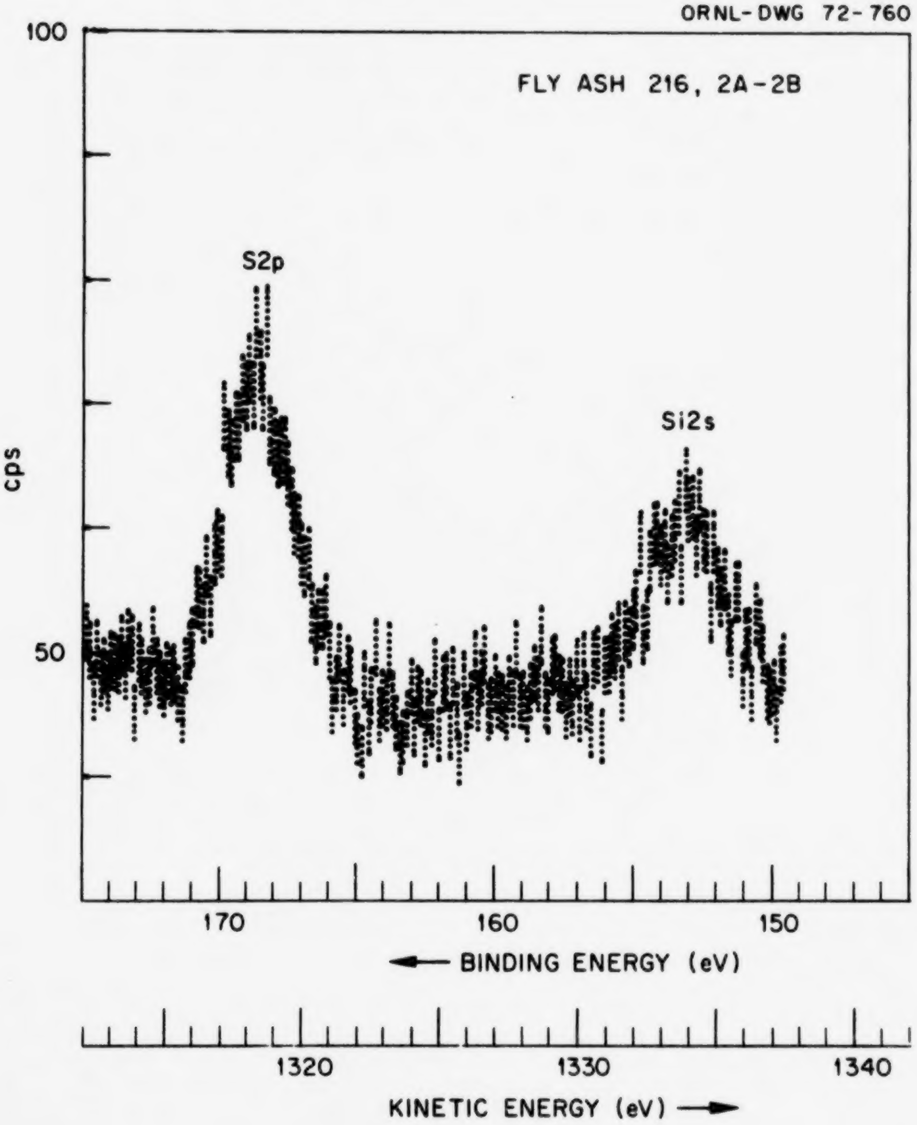
ORNL-DWG 72-760
FLY ASH 216, 2A-2B
100
cps
50
S2p
Si2s
170
160
150
BINDING ENERGY (eV)
1320
1330
1340
KINETIC ENERGY (eV)

Figure D9

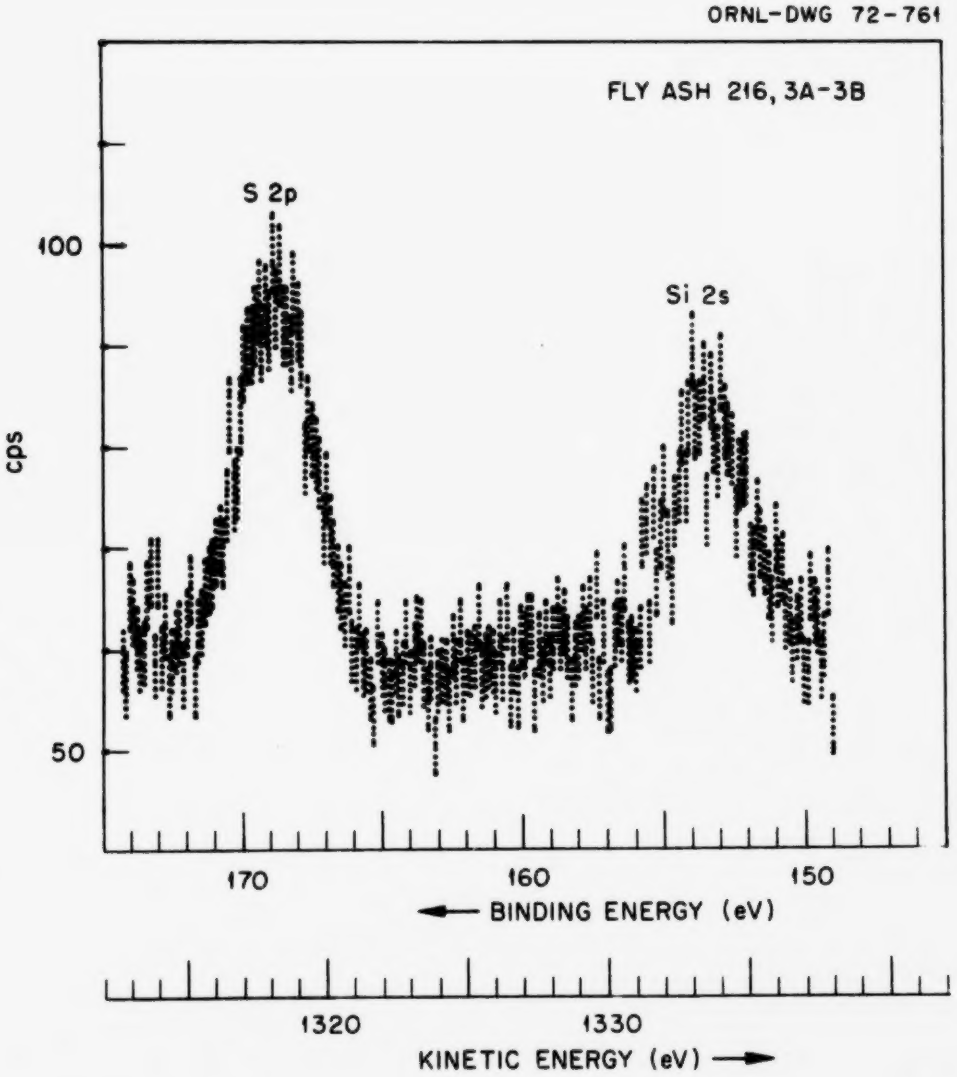
ORNL-DWG 72-761
FLY ASH 216, 3A-3B
S 2p
Si 2s
cps
100
50
170
160
150
← BINDING ENERGY (eV)
1320
1330
KINETIC ENERGY (eV) →

Figure D10

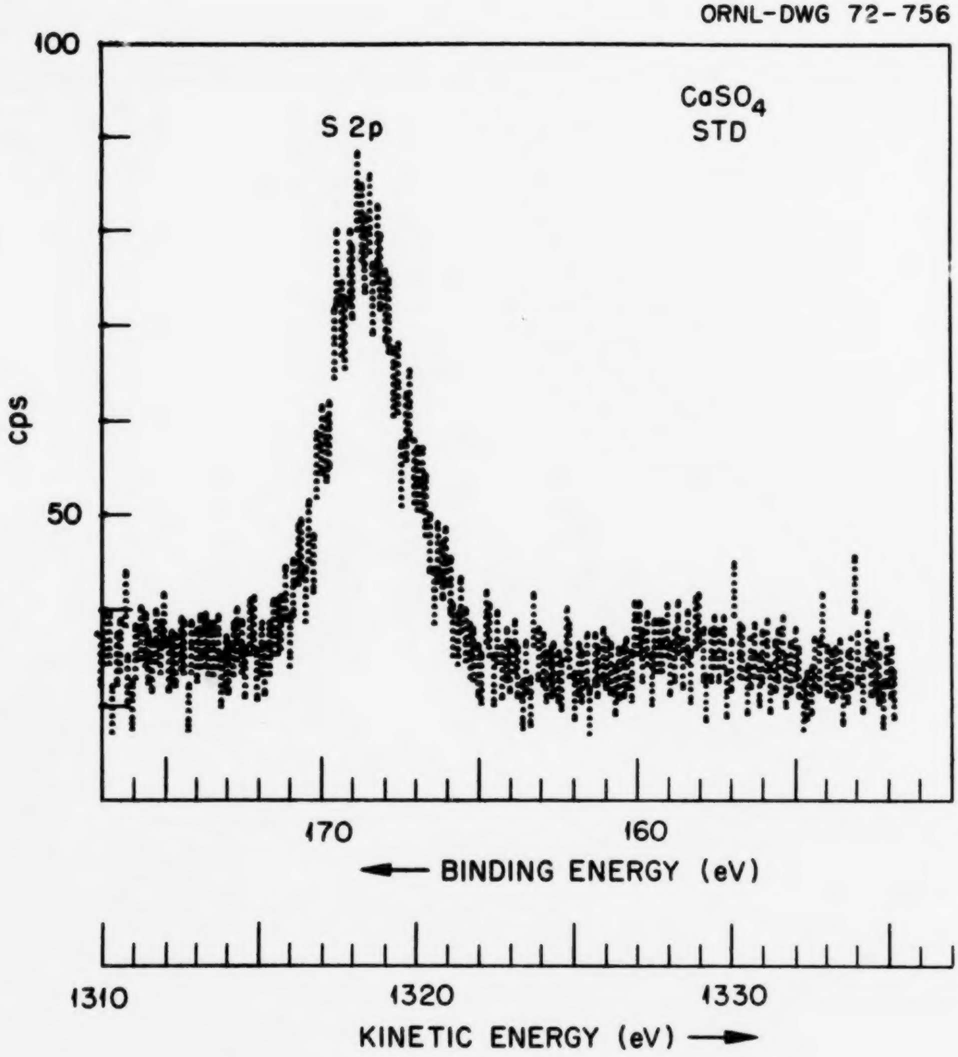
ORNL-DWG 72-756
100
50
cps
S 2p
$CaSO_4$
STD
170
160
← BINDING ENERGY (eV)
1310
1320
1330
KINETIC ENERGY (eV) →

Figure D11

ORNL-DWG 72-757

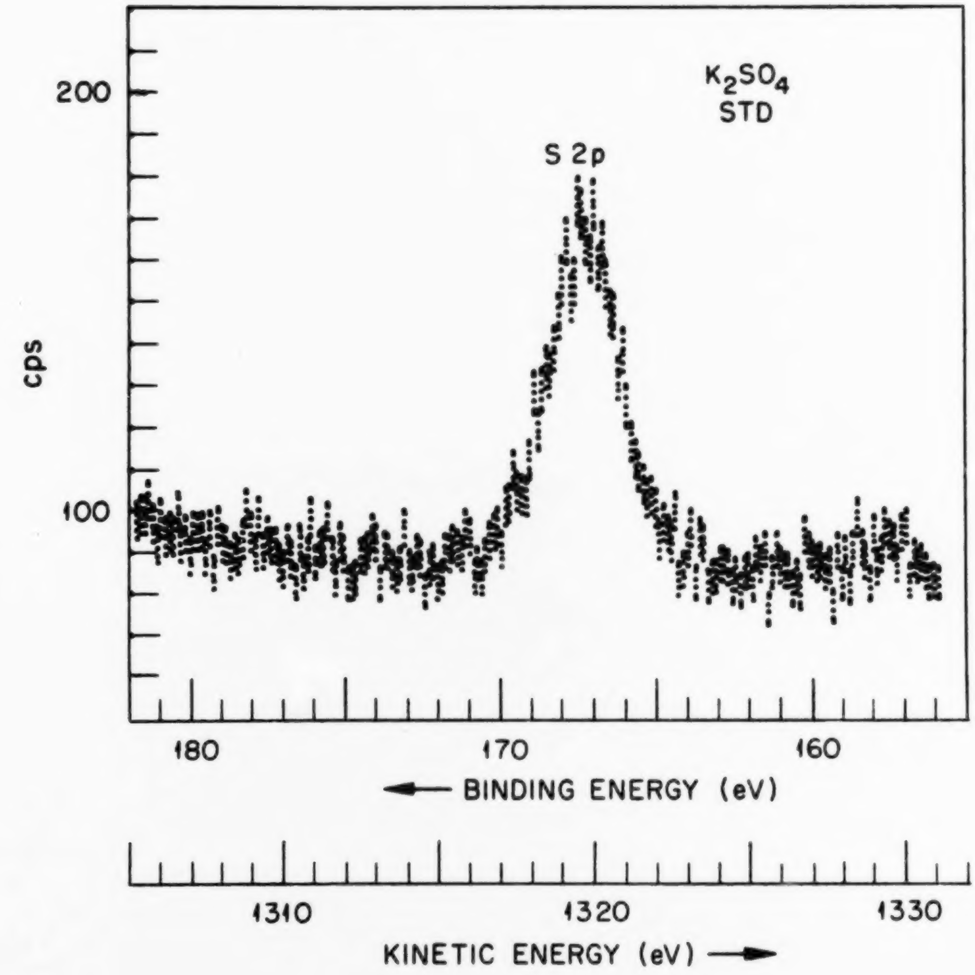

Figure D12

TABLE D1

FLY ASH SAMPLE NO.	52p BINDING ENERGY, ev	STANDARDS	52p BINDING ENERGY, ev
203-2	168.6	$CaSO_4$	168.6
206-2	168.1	$FeSO_4$	168.0
206-3	169.0	$Fe_2(SO_4)_3$	168.3
203-3	168.5	K_2SO_4	167.3
211-2	168.5	Na_2SO_3	165.8
211-3	168.2	S	164.3
216-3A-313	168.8	Na_2S	160.8
216-2A-2B	168.7		
221-3	168.8		
221-2	168.8		

DISCUSSION OF THE RESULTS OF SURFACE AREA MEASUREMENTS AND TOTAL SULFUR CONCENTRATION

The second column of Table D2 lists the surface areas (meters/gram) measured for each of the fly ash samples. The technique for measurement involved the adsorption of Krypton, using the theory of Brunauer, Emmett and Teller (BET) for interpreting the results. The second column lists the total concentration of sulfur (weight percent) for each sample. For this analysis, a weighed portion of the specimen was decomposed in a bomb with sodium metal. The H_2S produced was vented from the bomb, trapped, and measured titrimetrically.

The data in columns 2 and 3 of Table D2 were used to estimate the maximum degree to which the fly ash surfaces could be covered with absorbed sulfur compounds. To do this, it was assumed that the sulfur was entirely segregated at the surface and that it was in the form of calcium sulfate. For calcium sulfate the crystallographic unit cell dimensions are approximately 6.1 Å x 6.9 Å x 6.9 Å. Each unit cell contains four molecules of $CaSO_4$. With these assumptions, and the total sulfur concentration data, one can calculate the volume of $CaSO_4$ that would coat each specimen. Dividing by the respective surface areas, the average thickness of the surface layers is obtained. It will be assumed that a "monomolecular layer" is one unit cell length in thickness, about 6.5 Å (average of 6.1 Å and 6.9 Å). Dividing by this thickness, the surface coverages in monolayers are obtained. They are listed in column 4 of Table D2.

Thicknesses as great as those in Table D2 would cause the fly ash specimens to behave as if they were pure $CaSO_4$; and it appears that this is the case. If a comparison of the intensities (above background) for the S2p peaks of the fly ash specimens to those of the $CaSO_4$ and K_2SO_4 standards is made, it is found that they are approximately the same.[*] Because photoelectrons have a limited escape depth from solids, this technique is able to examine only very thin surface layers of specimens. The calculated thicknesses in Table D2 are, in most cases, greater than the escape depth.

---

[*] In comparing peak intensities, corrections must be made for changes in x-ray tube power. Some specimens were run at a power 50% lower than that used for the other specimens: 221-2, 216, 2A-2B; 216, 3A-3B; 221-3, $CaSO_4$.

TABLE D2

FLY ASH SAMPLE	BET SURFACE AREA, M^2/gm	TOTAL CONC. SULFUR, %	THICKNESS OF COVERAGE, MONOLAYERS
221-2	1.94	0.58	6
221-3	1.63	1.04	13
216-2A-2B	0.42	0.78	39
216-3A-3B	1.39	1.52	23
206-3	0.70	0.80	24
211-3	1.50	0.52	7
203-3	1.49	1.67	23
211-2	2.12	0.55	5
206-2	0.65	0.615	20
203-2	2.80	2.48	18

The calculated surface thickness in Table D2 is thus consistent with the assumption that almost all of the sulfate of the specimens is concentrated at the surface. The magnitude of the S2p peaks support this also. If the sulfate had been dispersed homogeneously in the solid phase, the photoelectron peaks would have been 20-40 times less intense.

OBSERVATIONS OF SILICON PEAKS

In Figures D4-D10, the Si 2S peak is presented along with the S2p peaks. In figures D13-D14 Si 2p peaks for two of the fly ash specimens are shown. The broadening of the silicon peaks toward lower binding energies suggests that there may be more than one chemical state present. The binding energy of the maximum of the peak corresponds to silicon as silicates or as SiO_2, but there may be lower oxidation states (silicon carbide?). The broadening could also be due to silicon being present in several types of glass phases. A firm statement cannot be made at this time about whether or not silicon is present in more than one chemical state. Further study is necessary to be sure that photoelectron peaks or Auger peaks[1] from other elements are not causing the broadening of the silicon peaks.

EXAMINATION OF FLY ASH SAMPLE NO. 203-2 BY INFRARED SPECTROSCOPY

Experiments were performed to establish the feasibility of obtaining information regarding the composition and nature of fly ash by a direct measurement of the infrared absorption spectrum. Sample No. 203-2 was mulled with nujol and spread on a AgBr window. The spectrum of this sample was measured with a Perkin-Elmer model 621 spectrophotometer and with a Digilab FTS-20 Fourier transform spectrophotometer. The results are shown in Figure D15. Spectrum A was recorded on the 621, and spectrum B was recorded using the FTS-20 system.

The absorption bands in the 450 cm^{-1}, 600 cm^{-1}, and 1000-1200 cm^{-1}, regions are due to SO_4^{2-} ion vibrations. The bands at 675, 730, 780, and 795 cm^{-1} may be due to CO_3^{2-} ion vibrations; a few additional experiments could confirm this assignment. These measurements show that infrared spectral studies with fly ash samples can provide rapid qualitative

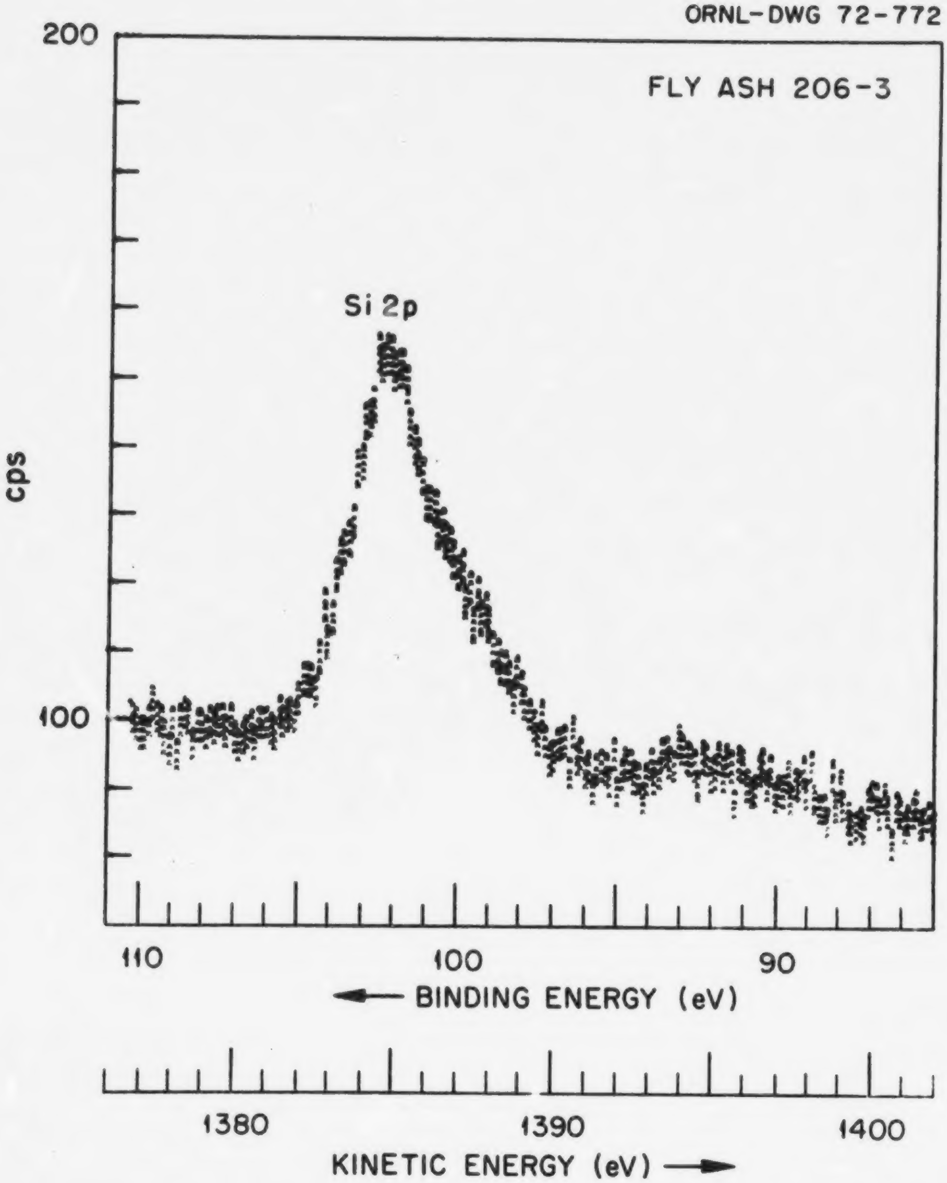
ORNL-DWG 72-772
FLY ASH 206-3
Si 2p
200
100
cps
110
100
90
← BINDING ENERGY (eV)
1380
1390
1400
KINETIC ENERGY (eV) →

Figure D13

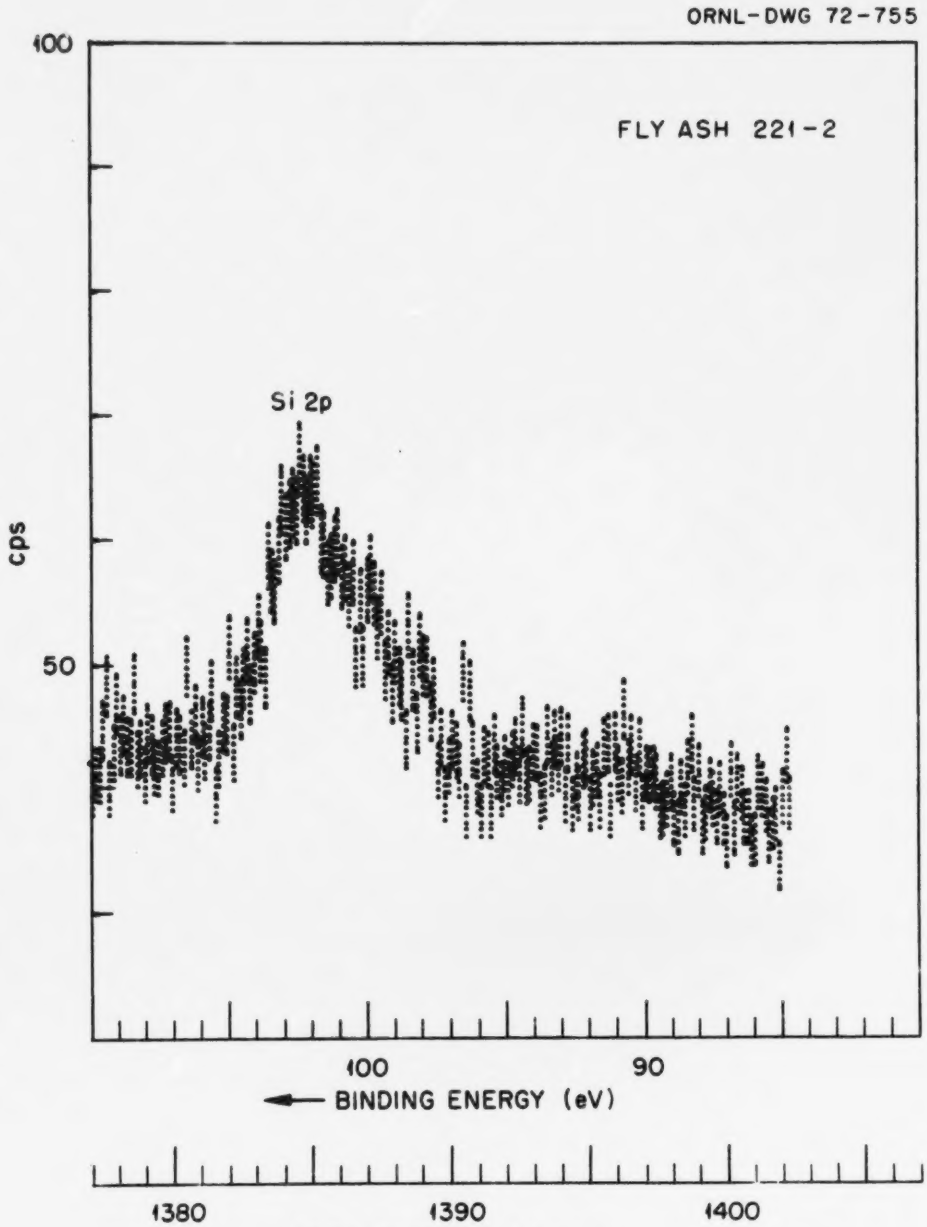
ORNL-DWG 72-755
FLY ASH 221-2
Si 2p
cps
100
50
100
90
← BINDING ENERGY (eV)
1380
1390
1400
KINETIC ENERGY (eV) →

Figure D14

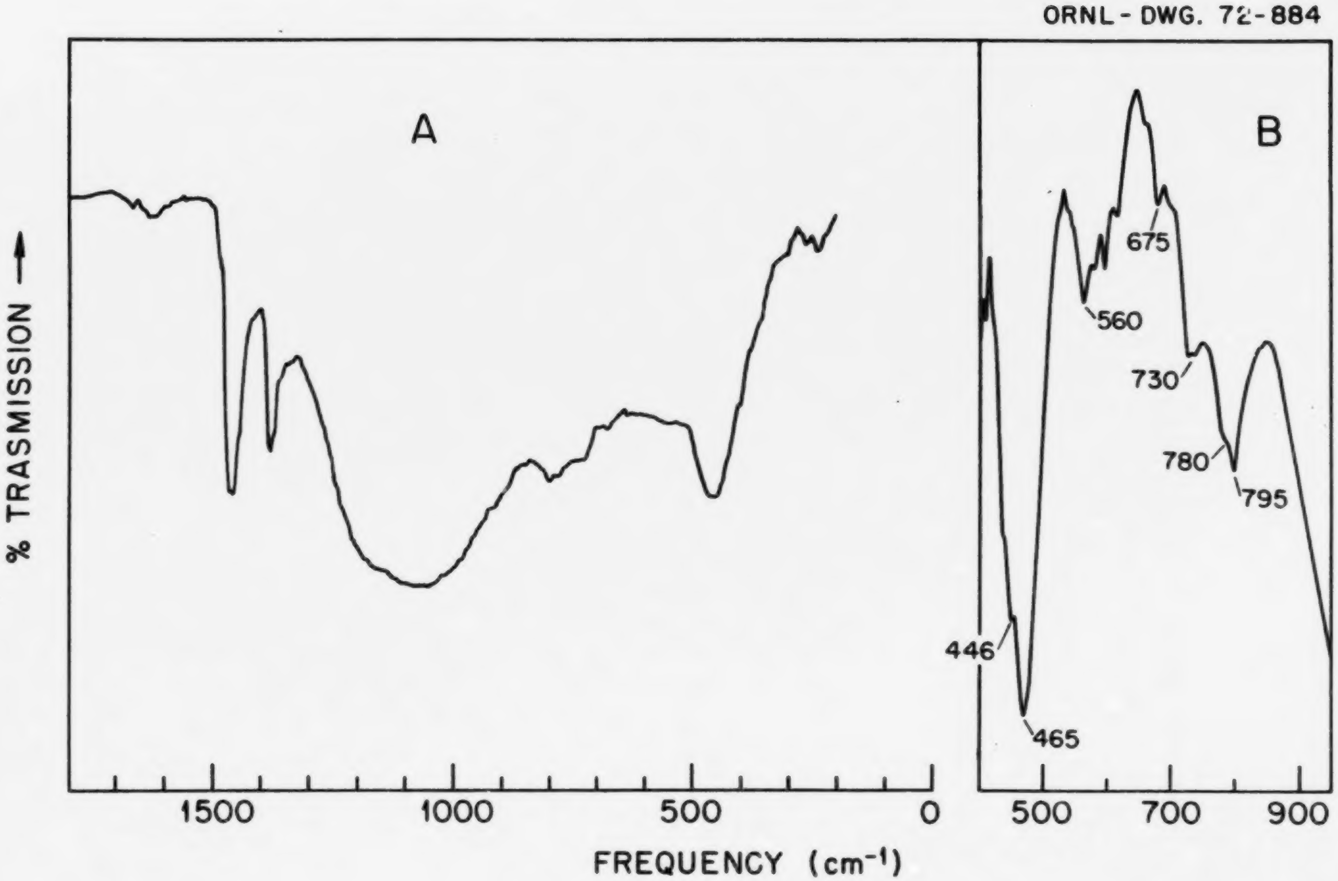
ORNL-DWG. 72-884
A
B
% TRASMISSION
1500
1000
500
0
500
700
900
FREQUENCY (cm⁻¹)
446
465
560
675
730
780
795

Figure D15

answers as to composition. With some simple procedures in sample treatment, Raman spectroscopy could be applied as well in providing additional information.

REFERENCES

1. K. Siegbohn *et al*. *ESCA: Atomic Molecular and Solid State Structure* Studied by Means of Electron Spectroscopy (Almquist, Uppala, Sweden, 1967).

2. L. S. Hulett, R. A. Carlson, B. R. Fish, F. L. Durham, *Proceedings of the Symposium on Air Quality*, 161st National Meeting of ACS, Plenum Publishing Corp., New York, N. Y.